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Epidemiology Feasibility Study: Effects of Noise on the Cardiovascular System. Appendix B Annotated Bibliography. Literature: The Effects of Noise on the Cardiovascular System

South Carolina Univ., Columbia

Prepared for

Environmental Protection Agency
Washinton, DC

Jul 81

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This bibliography is based on a comprehensive search of the world literature on the epidemiologic studies of the effect of noise on the cardiovascular system in man. It is composed of a critical analysis of thirty-five studies published in the English literature and forty-four studies from foreign journals translated for this evaluation. The assignment of numerical scores and ratings are discussed in the narrative report accompanying this bibliography. The assessment criteria employed, the assessment forms devised for standardization of the critiques and summarizations of the evaluations follow.

KEYWORDS: *Bibliographies, *Noise(Sound),
*Stress(Physiology), *Cardiovascular system.

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EPIDEMIOLOGY FEASIBILITY STUDY: EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

APPENDIX B

ANNOTATED BIBLIOGRAPHY

LITERATURE: THE EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

EPA 550/9-81-103 B

By: Shirley J. Thompson, Ph.D.

July 1981

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EPIDEMIOLOGY FEASIBILITY STUDY:
EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

APPENDIX B

ANNOTATED BIBLIOGRAPHY

LITERATURE: THE EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

By: Shirley J. Thompson, Ph.D.

July 1981

TABLE OF CONTENTS

Page

1. INTRODUCTORY NOTE B-1

2. CRITERIA FOR ASSESSMENT AND SUMMARY FORMAT FOR STUDY REVIEW B-2

2.1 Exposure Variable Noise Criteria B-2
2.2 Exposure Variable Noise Summary Format B-4
2.3 Response Variable Cardiovascular Disease Criteria B-5
2.4 Response Variable Cardiovascular Disease Summary Format B-6
2.5 Epidemiologic Study Evaluation Criteria B-7
2.6 Epidemiologic Study Evaluation Summary Format B-9

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EPA FEASIBILITY STUDY: THE EFFECTS OF NOISE ON THE CARDIOVASCULAR SYSTEM

INTRODUCTORY NOTE

This bibliography is based on a comprehensive search of the world literature on the epidemiologic studies of the effect of noise on the cardiovascular system in man. It is composed of a critical analysis of thirty-five studies published in the English literature and forty-four studies from foreign journals translated for this evaluation. Four tasks were involved in the evaluation process.

(1) Development of methodologic criteria for evaluating:

the adequacy of the noise parameters;
the quality of the cardiovascular response measures;
the overall validity of the study.

(2) Critical review of each article by an expert review team composed of an audiologist, cardiologist, and epidemiologist.

(3) Summarization of the three independent evaluations of the review team by the project director.

(4) Assignment of a numerical score to each component of the study evaluated resulting in three scores for each study:

a noise exposure rating;
a health effects score;
an epidemiologic-methodology score.

The assignment of numerical scores and ratings are discussed in the narrative report accompanying this bibliography.

The assessment criteria employed, the assessment forms devised for standardization of the critiques and summarizations of the evaluations follow.

Criteria for Judging the Exposure Variable - Noise

Terms used should be compatible with recognized standards such as ANSI S1.1-1960 (R1976) American Standard Acoustical Terminology and ANSI S3.20-1973 (R1978) American National Standard Psychoacoustical Terminology.

I. Noise Description
- A. Type of noise (as: steady, nonsteady, impulsive, etc.)
- B. Frequency compositon (as: pure tone, narrow-band, wide-band, specified)
- C. Levels: (in decibels) the type of noise must be indicated by the further modifier or context.

  "The physical quantity measured, the reference quantity, the instrument used, and the bandwidth or other weighting characteristic must be indicated."

  For air-borne sound, unless specified to the contrary, noise level is the weighted SPL called sound level; the weighting must be indicated.

  Sound Pressure Level (SPL). SPL in decibels of a sound is 20 times the logarithm to the base 10 of the ratio of the pressure of this sound to the reference pressure. The reference pressure should be explicitly stated.
- D. Duration of exposure (in msec., sec., min., hrs., days, years, etc.)
- E. Source (as: machine, engine, musical instrument, etc.)

II. Instrumentation
- A. Type(s)
  - Sound Level Meter (SLM): "An instrument including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement of noise and sound levels in a specified manner."

    Type 1 = precision SLM allows error of 1.5 dB. Acceptable. Preferred.

    Type 2 = general purpose SLM. Acceptable.

    Type 3 = survey SLM allws error of ± 7.5 dB. This type SLM should not be used in a noise study because of its comparative lack of precision.

    Note: Specifications for sound level meters are given in ANSI S1.4-1971 (R1976) American National Standard Specification for Sound Level Meters.
  - Oscilloscope
  - Impulse meter
  - Dosimeter, etc.
  - Instrument used appropriate to the type of noise defined.
  - Impulse or impact noises should be measured with an impact analyzer or oscilloscope.
- B. Make & Model
  - Manufacturer plus Model name or number specified.
  - Quality of the instrument relative to known techniques at the time of the study and relative to current knowledge.
- C. Compliance with recognized standard such as ANSI or ISO Standards (cited in article)
  - All instruments used in the studies should meet or exceed recommendations of a recognized standard such as ANSI or ISO Standards.
  - Evidence that instruments were properly calibrated in a manner compatible with ANSI guidelines (i.e., ANSI S1.10-1966 (R1976) American Standard Method for the Calibration of Microphones.

III. Environment
   A. Type - Sound field, sound-treated room, open area, underwater, reverberant room, etc.
   B. Controlled or Uncontrolled - Conditions constant or conditions varying unpredictably.

IV. Measurement Procedure
   A. Type - Degree to which a standard technique is used. (Specified as to location of measuring device, etc.)
   B. Compliance with recognized standard such as ANSI or ISO Standards (cited in article).
      - All measurements should be accomplished in a manner compatible with guidelines published by ANSI, e.g., ANSI S1.2-1964 (R1976) American Standard Method for the Physical Measurement of Sound and/or ANSI S1.3-1971 (R1976) American National Standard Methods for the Measurement of Sound Pressure Levels.
        For example, reporting of measurement procedures should specify necessary information such as:
      - Calibration of instruments prior to and following measurements.
      - Correct manipulation of the instrument itself.
      - Correct and detailed recording of the measurements.

V. Subjects
   A. History of vocational noise exposure
      - Including all jobs which involved work around noise
      - History of previous and/or current involvement in a hearing conservation program
   B. History of avocational noise exposure
      - Including all non-working activities around noise
      - Nature and extent of any military experience
   C. Hearing thresholds obtained before and after noise exposure study and the adequacy of such determinations
      - With at least 14 hours away from the noise before testing is done
   D. History of ear disease
      - Where history of disease, problem identified and duration reported
   E. Otological examination
      - To insure that factors influencing hearing are identified (as impacted cerumen, m.e. disease, etc.)

VI. Investigative Personnel
   A. Professions - clearly stated versus not revealed by information available
   B. Qualifications - clearly stated versus not revealed by information available

Scoring Guide
2=Criterion Met
1=Crit. Partially Met
0=Crit. Not Met
I= Invalid Crit. Used
NA=Not Applicable - Do not include in %.

Summary Format for Study Review - Noise Exposure

Citation No.____ Title:______________________________

SCORE **CATEGORICAL CRITERIA**

I. Noise Description

____ A. Type
____ B. Frequency Composition
____ C. Levels
____ D. Duration of Exposure
____ E. Source

II. Instrumentation

____ A. Type(s)
____ B. Make and Model
____ C. Compliance with ANSI or ISO Standards

III. Environment

____ A. Type
____ B. Controlled or Uncontrolled

IV. Measurement Procedure

____ A. Type
____ B. Compliance with ANSI or ISO Standards

V. Subjects

____ A. History of vocational noise exposure
____ B. History of avocational noise exposure
____ C. Hearing thresholds obtained before and after noise exposure study
____ D. History of Ear Disease
____ E. Otological Examination

VI. Investigative Personnel

____ A. Professions
____ B. Qualifications

VII. Other Significant Factors

34 Total Possible Points

VIII. Summary Comments and Overall Rating

Rate the quality of the study for noise exposure (lowest = 0 to 9 highest) ____

Rate the study as to overall validity (lowest = 0 to 9 highest) ____

Indicate specific areas of inadequacy:

Include study in dose-response considerations: No____ Yes____

Rating Scale by % of Criteria Met
9 = 91-100
8 = 81-90
7 = 71-80
6 = 61-70
5 = 51-60
4 = 41-50
3 = 31-40
2 = 21-30
1 = 11-20
0 = 0-10

Criteria for Judging the Response Variable - Cardiovascular Health Effects

Disease states and risk factors were judged according to the following criteria.

I. Diagnostic criteria for clinical manifestations or diseases, i.e., New York Heart Association Classification.

II. Documentation of pre-existing cardiovascular disease.

III. Time relationships of exposure events to clinical manifestations, disease development, clinical events.

IV. The natural course of disease states.

V. Risk of specific clinical manifestations or pathophysiological responses.

VI. Methodology for determining response - variability of physiologic response measurements. This shall include but not be limited to procedures used, reliability and validity of the instrumentation, qualifications of personnel making determinations, consistency of the testing process.

Because of the scope and complexity of the biochemical, physiological, pathological, behavioral effects and clinical manifestations to be evaluated, standard criteria for specific health effects were determined and applied as appropriate.

Scoring Guide
2=Criterion Met
1=Crit. Partially Met
0=Crit. Not Met
I=Invalid Crit. Used
NA=Not Applicable - Do not include in %.

Summary Format for Study Review - Health Effect

Citation No.____ Title:____________________

SCORE	CATEGORICAL CRITERIA
____	I. Diagnostic Criteria
____	II. Documentation of Pre-Existing Cardiovascular Disease
____	III. Time Relationships of Exposure to Health Responses
____	IV. Natural Course of Disease State
____	V. Risks of Specific Responses
____	VI. Methodology
12 Total Possible Points	

Rate the quality of the study for health effects (lowest = 0 to 9 highest) ____

Rate the study as to overall validity (lowest = 0 to 9 highest) ____

Indicate specific areas of inadequacy:

Include study in dose-response considerations: No____ Yes____

Rating Scale by % of Criteria Met
9 = 91-100
8 = 81-90
7 = 71-80
6 = 61-70
5 = 51-60
4 = 41-50
3 = 31-40
2 = 21-30
1 = 11-20
0 = 0-10

Criteria for Judging Epidemiologic Studies of the Nonauditory Effects of Noise on Man

I. Classification of Study Design
  Statement of Objectives (for clarification, not to be rated)
  - Stated in terms of anticipated risks (evidence of literature support)
  - Clear and justified in terms of existing scientific information

  A. Strength of the Design in Determining Etiology
    1. Experimental Studies (Intervention)
      - Randomized Trial: of long-term effects
        : of short-term effects
    2. Observational
      - Cohort or historical prospective: with individual exposure determined
        : "ecological" exposure as opposed to individual
        : hearing-loss exposure cohort
      - Case-control
      - Cross-sectional: prevalence
        : demographic studies of risk or mortality or morbidity using individuals classified on all variables
        : ecologic (classification based on aggregate measures as distinct from single individuals)
      - Case series with implicit controls (not acceptable but if there is reason to review, use appropriate criteria and justify)
  B. Bias Potential in Design
    The extent to which study design reported/controlled for bias such as exposure suspicion bias and recall bias.
  C. Data Sources and Method of Data Collection
    1. Primary versus secondary data sources
    2. Data collected in a blind or double-blind manner - specify potential bias and reliability issues
    3. Potential bias related to data source such as survival, self-selection identified. (Rate a specific bias potential only once in a given study.)

II. Sample
  A. Type
    - Random population sample (describe on characteristics such as age and sex)
    - Retrospective cohort (exposure identified historically through records)
      : evidence of accounting for complete cohort; method of accounting for non-respondents justified
      : if not complete cohort by noise exposure, detailed description of method for selection with potential selection bias addressed
    - Case-control Series
    - Other samples from selected, but well defined populations
  B. Sample size adequate for testing stated hypothesis (sample size calculations provided)
  C. Follow-up
    - Attrition - consider size of loss rate in each exposure category
  D. Potential Bias and Its Control
    1. Selection Bias - Criteria and rationale for inclusion and exclusion of subjects indicate potential bias was considered including healthy worker effect
    2. Selective-Survival Bias
    3. Migration Bias - Length of follow-up given with description of direction and magnitude of bias in results due to non-comparable follow-up

III. Specification of the Exposure and Response Variables
  A. Noise Exposure as an Epidemiologic Variable
    In addition to separately specified criteria:
    - "Exposure" applied to individuals as opposed to "ecological" measure
    - Completeness of exposure history - past to present
    - Single versus multiple assessments of exposure for any given time period
    - The extent to which the reliability and validity of exposure measurement is appropriate for assessing risk in large populations and/or selected groups at potentially high risk
    - Potential measurement bias
  B. Health Outcomes as Epidemiologic Variables
    In addition to separately specified criteria:
    - Extent to which reliability and validity of methods are appropriate for epidemiologic purposes
    - Extent to which each individual was assessed on the response variable
    - Extent to which the study depends on existing data from records: collected for study with reliability and validity checks built in versus dependent on well documented records versus collected for clinical or other than research purposes
    - Potential measurement bias

IV. Treatment of the Data: Analytic and Statistical Procedures for Judging Causal Significance

A. The Strength of the Association

1. Epidemiologic effect parameter used to quantify the strength of the association for categorical variables:
   - Relative risk
   - Attributable risk
   - Odds ratio
   - Population attributable risk (if appropriate)
2. Epidemiologic effect measure used to quantify the association for continuous variables:
   - Correlation coefficient
   - Regression coefficient
3. Temporal relationship
   Did study demonstrate that noise exposure preceded physiological response (important in long-term effects or chronic effects)?
4. Consistency
   Were the observed relationships consistent with findings of other studies?
5. Coherence
   Do study results conflict with generally known facts and biology of the disease?

B. Appropriate statistical tests of significance and confidence intervals provided for risk assessments in 1 and 2 above

C. When a meaningful relationship is observed, is a dose-response evident in the data?
- Within the single study
- In an ecological sense: Can data from several studies be evaluated together?

D. Confounding
Were potentially confounding variates (known strong risk factors) controlled through matching, stratification or statistical analysis?

Scoring Guide
2=Criterion Met
1=Crit. Partially Met
0=Crit. Not Met
I=Invalid Crit. Used
NA=Not Applicable -
Do not include in %.

Summary Format for Judging Study Methodology

Citation No.__ __Title:______________________________

SCORE	CATEGORICAL CRITERIA
	I. Study Design Objective(s)
____	A. Power of the Design
____	B. Bias Potential in Design
____	C. Data Sources and Method of Data Collection
	II. Sample:
____	Type
____	Size
____	Follow-up - Selection Bias
	III. Specification of Exposure and Response Variables
____	A. Noise Exposure
____	B. Health Outcomes
	IV. Judging Causal Significance
____	A. Strength of the Association; Consistency; Specificity; Temporal Relationship
____	B. Statistical Significance
____	C. Evidence of Dose-Response Relationship
____	D. Control for Potential Confounders
24 Total Possible Points	

Rate the quality of the study for epidemiologic method (lowest = 0 to 9 highest) ____

Rate the study as to overall validity (lowest = 0 to 9 highest) ____

Indicate specific areas of inadequacy:

Include study in dose-response considerations: No_____ Yes_____

Rating Scale by %
of Criteria Met
9 = 91-100%
8 = 81-90
7 = 71-80
6 = 61-70
5 = 51-60
4 = 41-50
3 = 31-40
2 = 21-30
1 = 11-20
0 = 0-10

Citation: Andriukin, A.A.: Influence of Sound Stimulation on the Development of Hypertension: Clinical and Experimental Results. Cor et Vasa 3(4):285-293, 1961. (English)

Researchers and Institution where research performed:
Institute of Therapy, Academy of Medical Sciences of the U.S.S.R., Moscow.

Stated Purpose: To present (a) results of a large scale examination of workers from four workshops, differing as to the type of noise and (b) experimental results of the influence of intense high frequency noise on the arterial BP in laboratory rats.

Study Design and Sample:
: 4 occupational groups in industry.
: Cross-sectional data.
: Sample of 307 subjects from toolmaker's workshop;
200 subjects from sorting workshop;
462 subjects from workshop with automatic lathes;
263 subjects in workshop producing ball bearings.
: Sample included men (676) and women (556) although BP data is not presented in sex specific form; variation in selection into the 4 work areas and into the study sample is unknown although author states older workers might be transferred to lighter work.

Data Sources: Primary data collection by investigators.

Bias Potential in Design:
Potential for selection bias and unequal response among work groups. Data not provided for assessing this.

Noise Exposure:
Noise Description:
Source : Machines and miscellaneous activities in various shops; specific noise sources not reported.
Type : Workshop noises in a plant; unsteady.
Frequency Composition: Not explicitly reported - stated that stimulus in mixed, but "high frequencies dominate its spectrum, particularly in the workshop with automatic lathes and the workshop producing ball bearings".
Levels: Toolmaking = 93 db; sorting room = 103 db; automatic lathes = 103 db and workshop producing ball bearings = 120 db.
Duration of Exposure: Precise exposures not reported; 7-8 hours daily in three shifts which alternated weekly. Approximately 50% of the workers had been working in the plant for more than 10 years.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Workshop, physical layout not described relative to workers.
Subjects : 50% of subjects had been workers in the plant studied and in work which had "changed but little". History of other work exposures, avocational exposures, hearing thresholds, history of ear disease, otological examination,etc., not reported.

Evaluation : Poor regarding noise parameters. Although noise information was obtained, frequency composition of noise was not reported and specific exposures of workers to noise were not reported precisely. Exposures could vary widely between workers over the years depending on their specific duties.

Health Effects:

CVS Response : BP recorded during work after a 10 minute break, on right arm using Riva-Rocci apparatus and Korotkov"s Method. Repeated until constant values obtained. BP 130/90 taken as upper limit of normal for subjects < 40 years of age and 140/90 mm. Hg. for subjects over 40 years.

Evaluation : Does not state whether high BP was defined as > 90 diastolic or > 130-140 systolic or both and how many subjects fell into these categories - this is important in older age where systolic elevation may increase more with age and thus increase the "hypertensive group". Definition of which phase was used for diastolic (IV or V) was not stated. Quality of data was improved by the taking of several BP's, however, "repeated till constant values were obtained" is not replicable. Raw data are not available in the paper for statistical comparisons. There is no evidence of control for confounding variables.

Judging Causal Significance:

Strength of the Association: Not given.

Statistical Methods: No statistical test employed. Data displayed by percentages.

Control for Potential Confounders:

Incomplete control of age, exposure time, sex, socio-economic class, medications, stress at work such as rotating shifts, co-morbidities, etc.

Conclusions:

Authors : "In workshops with intense noise (sorting room, automatic lathes, ball bearings) the disease (hypertension) is found more frequently than in the less noisy workshop (toolmaking). . . . In the noisier workshops the morbidity is almost twice as high in persons under 50 years of age. . . the percentage of patients increases with the duration of employment; particularly marked is the increase after five years of work in the noisiest workshops. . . Among workers exposed for prolonged periods to intense noise (above 93 db) and high frequency noise this disease is encountered on an average twice as frequently as in workers of various (relatively quiet) factories in Moscow."

Overall Evaluation:

The study used prevalence data (referenced as incidence) with no attempt at identifying true cohorts within the 4 worksites. Non-participation and attrition within each group was not described. There was incomplete control of age and other confounding variables. Study could have been improved by looking for evidence of hypertension by one definition and/or by mean levels of BP by age, sex and exposure time among the 4 work groups. No statistical tests were performed and no raw data available to the reader. Other Moscow industrial groups as a comparison are not appropriate unless comparisons are at least age-sex specific.

(Scores on scale from 0-9)

Noise Exposure = 2
Health Effects = 3
Epidemiologic Method = 3

Citation: Antonova, K.P.: Effect of General Vibration on Equipment Operators in Ore-Dressing Plants. Hygiene and Sanitation 36(6): 457-460, 1971. (English)

Researchers and Institution where research performed:
Occupational Health Research Institute, Krivoi Rog, Russia.

Stated Purpose: Study of the vibration parameters at worksites and functional change to provide a physiological hygienic evaluation of this vibration.

Study Design and Sample:
: Occupational groups of mill operators, assistants and separator operators.
: Cross-sectional study of workers prior to work, six hours after beginning of shift and after work.
: Sample of 33 workers aged 20-45 during 90 work shifts.
: No controls.
: No data on sampling or selection.

Data Sources : Apparently on-the-job measures.

Bias Potential in Design:
No controls although before-after measures taken. Difficult to determine if all or selected workers were tested.

Noise Exposure:
Noise Description:
Source : Workers in mills or separators mentioned as being exposed to noise; however, noise levels of deslimers, conveyors and classifiers not mentioned. Classifiers had higher reported vibration velocities than the mills or separators.
Type : Ore-Dressing plant (industrial noise).
Frequency Composition: Various spectral compositions (mills); low frequency or low-medium frequency noise (separators).
Levels: 92-112 dB (mills); 97-104 dB (separators); other noise generator levels not reported.
Duration of Exposure: 74-97% of their working time for mill operators and their assistants and separator operators.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled worksite of ore-dressing plants.
Subjects : Employment varied from 3 months to 11 years; history of vocational, avocational noise exposure not given. History of ear disease, use of hearing protectors, etc. not given.
Evaluation : Although information on vibration was reported well and in detail, noise information was poorly reported. Study was designed essentially to measure vibration effects.

Health Effects:
CVS Response : Pulse rate, brachial and temporal arterial pressure.
Evaluation : No data provided for assessment of quality.

Judging Causal Significance:
Strength of the Association: None given.
Statistical Methods: None given. Apparently within-group differences were noted in the course of the work day but no comparisons were made between the groups.

Control of Potential Confounders:
No evidence of control other than repeat measures on the same individual.

Conclusions:
Author : "The pulse rate becomes faster in the course of the shift in the majority of investigative personnel." Brachial and temporal arterial pressures rose in mill operators; operator assistants had 2-6 mm. increases in brachial arterial pressure whereas the separator operators showed no significant change in arterial pressure. For the prevention of occupational diseases, medical specialists need to pay attention to nervous and cardiovascular systems.

Overall Evaluation:
Paper does not include sufficient data to allow comparisons or conclusions relative to noise exposure and health effects.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method = 0

Citation: Brown, J.E., Thompson, R.N. and Folk, E.D.: Certain Non-Auditory Physiological Responses to Noise. American Industrial Hygiene Journal 36(4):285-291, 1975. (English)

Researchers and Institution where research performed:
Federal Aviation Administration, United States Department of Transportation, Aeronautical Center, Oklahoma City, Oklahoma.

Stated Purpose: (a) To select a population of workers known or expected to be exposed to high occupational noise levels; (b) to confirm that they did experience such exposure; (c) to investigate the possibility that their exposure may have produced some measurable non-auditory alterations in physiological functions.

Study Design and Sample:

: Occupational groups from airline industry.

: Historical prospective/cross-sectional design. Subjects identified had eight years participation, but there is no evidence that these represented complete cohorts of eight years previously.

: Sample of 29 pilots in the executive annual physical examination program for at least eight years compared to 29 controls of non-flying executives with at least eight years in the program.

Data Sources : Health records and annual physical examination data.

Bias Potential in Design:
Good possibility that healthy worker effect is operating among the pilots. Problems inherent in using retrospective health data collected for other than study purposes. Unclear specification of "cohorts" suggests there may be high risk of selection bias due to attrition. Pilots and executives are probably not comparable groups relative to variables of interest in this study.

Noise Exposure:
Noise Description:
Source : Aircraft engines.
Type : Unsteady exposures from aircraft.
Frequency Composition: Not reported.
Levels: Eight hour Damage Risk Criteria (90 dBA) contour was equalled or exceeded in all aircraft except the jet transports. In five aircraft, four hour DRC (95 dBA) were exceeded. In one aircraft the two hour DRC (100 dBA) was exceeded.
Duration of Exposure: 6000 or more hours of flying time.
Instrumentation: Not reported - "noise levels obtained from various unpublished agency projects."
Measurement Procedure: Not reported.
Environment : Uncontrolled; aircraft cockpits.

Subjects : History of vocational noise exposure only in terms of flying time. Hearing thresholds monitored annually; annual physicals routinely included otological examination; however, this was not mentioned specifically. History of ear disease and avocational exposures not reported. Analysis of audiometric data indicated that the pilots demonstrated characteristics of noise-induced hearing loss that were not found in the controls.

Evaluation : "6000 hours flying time or more" leaves too much doubt as to what the actual individual noise exposures regarding duration and intensity were for the pilots. Exact noise exposure not known unless monitored during exposure time. No noise exposure levels for controls.

Health Effects:

CVS Response : Recorded measurements of heart rate, systolic and diastolic BP, cholesterol and glucose from health records of each person.

Evaluation : Although criteria for BP measurement is not given, there is some quality control by having tests taken and procedures run by the same personnel throughout the study. Pilots and Executives may not be comparable groups because of other "stresses" on which the two differ and the variations in physical examination standards for the two groups. As a health effect it is difficult to know what heart rate change over time means.

Judging Causal Significance:

Strength of the Association: None noted.

Statistical Methods: A Randomized Complete Block Design with subjects as blocks was used with the t-test to detect differences between pilot and control group and F-test to evaluate degree of change over time.

Control for Potential Confounders:

Stratified by age; only ages 50-59 studied because there were too few subjects in other age groups; pilots and executives were essentially of the same socioeconomic status. Changes in dietary habits were noted but not controlled in the analysis.

Conclusions:

Authors : Changes in heart rate over the seven year period were statistically significant within and between populations, but did not show the decline expected from noise exposure. Changes in SBP were statistically significant within the populations, but not between the pilot and control group. No changes were observed in DBP. Cholesterol levels decreased with successive determinations in both groups, possibly due to dietary and exercise changes. Glucose levels decreased over time, but no significant difference between groups was noted. No changes due to noise exposure were observed in BP, heart rate, cholesterol or glucose levels. "...(a) either noise does not produce long-term non-auditory physiological responses, or (b) the noise levels to which these pilots are exposed are of such intensity to produce such responses, or (c) methods of measuring the physiologic parameters are not of sufficient sensitivity to detect responses as might be precipitated by noise."

Overall Evaluation:

Negative results may be related to small sample size. Although there was some quality control of the data, comparability of the test and control groups was not adequately demonstrated; possibility of selection bias was not addressed. It is unclear as to how a Randomized Complete Block Design was used in the analysis of non-random, retrospective data.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 8
Epidemiologic Method = 6

Citation: Cohen, A., Taylor, W. and Tubbs, R.: Occupational Exposures to Noise, Hearing Loss, and Blood Pressure. ASHA Reports 23(10): 322-326, 1980. (English)

Researchers and Institution where research performed:

: Cohen and Tubbs: National Institute for Occupational Safety and Health, Cinncinnati, Ohio, U.S.A.

: Taylor: Wolfson Institute of Occupational Health, University of Dundee, Dundee, Scotland.

Stated Purpose: To confirm that workers showing marked high-frequency hearing losses in their audiograms as evidence of excess occupational noise exposure, also display increased blood pressure and hypertension in disproportionate numbers.

Study Design and Sample:

: Occupational groups from a paper making plant in midwestern U.S.

: Noise induced hearing loss as a surrogate measure for noise exposure.

: Cross-sectional comparison of workers who met high-frequency hearing-loss criteria and as controls, the next scheduled worker with a normal audiogram.

: Sample of 51 workers who met high-frequency hearing loss criteria; 51 workers (control) with no more than 20 dB hearing level in either ear at any test frequency; 1200 employees screened to identify hearing loss group and controls.

Data Sources: Occupational noise and hearing survey.

Bias Potential in Design:

Selection bias may exist (if deaf and hypertensive, more likely to retire, or change jobs than if experiencing either problem alone); the validity of the study may be questioned in that the sample size may be too small to allow detection of significant differences in BP between the groups.

Noise Exposure:

Noise Description:

Source : Paper machines and cutting and sorting machines. Study uses surrogate measure of high frequency hearing loss as evidence of excessive noise exposure using hearing levels of 65 dB or more at 3000, 4000 and 6000 Hz.

Type : Papermaking plant in the U.S. with noise "quite steady and free of impact sounds."

Frequency Composition: Not reported.

Levels: Variable with paper machines about 98-102 dBA and cutting-sorting machines 85-92 dBA.

Duration of Exposure: Hearing loss group: 22.3 years at the job and control group : 12.5 years at the job.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Not described, but worksites indicate uncontrolled.

Subjects : Only years of working at the study plant were reported; no data as to history of avocational exposures. Subjects had no history or otoscopic evidence of ear pathology and differences between threshold readings for both ears were 10 dB or less in any frequency after wearing earplugs and earmuffs while at work during the test day.

Evaluation : High frequency hearing loss was used as evidence of excessive noise exposure. Noise stimuli were not identified as to frequency components and individual exposures could have varied widely. The authors' findings did not agree with those of Jonsson and Hansson who found a positive association between BP and noise. But, as the authors point out, these subjects are 13 years younger on the average than the Jonsson-Hansson sample.

Health Effects:

CVS Response : BP taken after 30 minutes rest (during which hearing test and health inquiry were performed); subject in recumbent position; two cuff sizes used with a wall mounted sphygmomanometer; BP taken by two technicians, trained by a medical officer and unaware of hearing status; BP read to the nearest 2 mm. Hg.; based on last two of three independent readings and included the first systolic phase, Phase IV and Phase V diastolic. Hypertension defined by WHO criteria of > 160/95. Pre-existing history and medication noted.

Evaluation : Age differences existed between hearing loss and control group with controls younger which should cause an error toward higher BP in the hearing loss group, all other factors being comparable. There were no differences noted in BP between the worker groups with hearing loss versus normal hearing.

Judging Causal Significance:

Strength of the Association: None observed.

Statistical Methods: Conclusions based on "statistical evaluation" and "covariate analysis designed to adjust for differences in age and body size", but no specific tests with data were reported. Findings not consistent with Jonsson and Hansson who used similar procedures.

Temporal Relationship: Unable to determine with cross-sectional, surrogate data.

Control for Potential Confounders:

Authors state that analysis controlled for age and body size, but groups varied considerably by age and there is some question as to whether hearing loss may have been due to aging rather than to noise exposure. Sample size may be too small for covariate procedure to work. Control group had experienced only 12.5 years at the job compared to 22.3 years for the hearing-loss group. No evidence of controlling statistically for race, comorbidities, length of exposure, temperature, humidity, etc. Study was conducted during hot summer months.

Conclusions:

Authors : "Statistical evaluation of the blood-pressure data found no reliable difference between the worker groups with high-frequency loss versus normal hearing even with covariate analysis designed to adjust for differences in age and body size (weight/height ratio)....Clearly, it is too early to draw any conclusions about noise as a causal factor in cardiovascular disease."

Overall Evaluation:

Study suffers from small sample size and possibly Type II error. This, in effect, is a cross-sectional design using hearing loss as a surrogate for noise exposure. A more rigorous design might be to identify all hypertensives in the industry and then examine the noise-induced hearing loss in hypertensives versus normotensives in a classical case-control mode. Additional information could be derived by correlating actual BP levels with noise-induced hearing loss, age, weight, race, exposure time (years employed) and, by partialling, discern a controlled relation between hearing loss and BP levels.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 8
Epidemiological Method = 6

Citation: Cohen, S., Evans, G.W., Krantz, D.S. and Stokols, D.: Physiological, Motivational, and Cognitive Effects of Aircraft Noise on Children. American Psychologist 35(3):231-243, 1980. (English)

Researchers and Institution where research performed:
Cohen - University of Oregon;
Krantz - Uniformed Services University of the Health Sciences;
Evans and Stokols - University of California, Irvine.

Stated Purpose: To examine the effects of aircraft noise on children.

Study Design and Sample:

: Community survey of school children.
: Cross-sectional design.
: All children (without hearing impairment at > 25 dB in either ear at 500, 1000, 2000, 4000 Hz) in the third and fourth grades of the four noisiest schools in the air corridor of Los Angeles International Airport with an equal number of classes from three quiet schools, group-matched on ethnic and racial distribution, % receiving AFDC and occupational and educational level of parents.
: Total of 262 subjects with 142 from noise schools and 120 from quiet schools.

Data Sources : Direct measurement of subject variables and classroom noise levels; noise contours were compiled by the Los Angeles International Airport for sound levels outside the home of noise school children.

Bias Potential in Design:

: Ecological fallacy.
: Self-selection into noise or quiet schools.
: Suspicion bias not controlled (home noise contours not available for quiet homes.)

Noise Expousre:
Noise Description:
Source : Aircraft overflights.
Type : Aircraft noise, nonsteady.
Frequency Composition: Not reported.
Levels : Mean peak in noise schools = 74 dB; in quiet schools = 56 dB. Highest reading in noise school = 95 dB; in quiet school = 68 dB. Noise contours (not reported) by Los Angeles International Airport used to approximate levels outside homes of noise school children.
Duration of Exposure: Not reported.
Instrumentation: Tracoustics Sound Level Meters, SLM S2A, compliance not reported.
Measurement Procedure: Sound levels monitored for one hour period in A.M. and a one hour period in P.M. with dB(A) peak sound levels also recorded. Measurements relative to the positions of children were not reported. Compliance with standards not reported.

Environment : Uncontrolled; classrooms. Positions of children and dimensions to physical characteristics of rooms were not reported.

Subjects : School children - 142 in noise environment and 120 in quiet rooms. History of avocational noise exposure and ear disease and otological condition of children were not reported. Hearing thresholds obtained after noise exposure.

Evaluation : Frequency composition and duration of exposure to noise not reported. Years enrolled in school taken as years of exposure may not accurately reflect actual durations of exposure to noise for each child. Levels of noise would be nonsteady due to aircraft being moving sources resulting in unknown cumulative durations. The one hour monitoring periods in the A.M. and P.M. may not accurately reflect the true noise environment for a total day.

Health Effects:

CVS Response : Mean of the second and third BP readings; single BP measurements taken on two consecutive testing days; coders blinded to experimental condition; automatic BP recorder (SR-2 Physiometrics), allegedly validated in another study was used; BP taken in a quiet room. Child had one reading prior to the testing time to allow adaptation to the procedure. No information given as to cuff size.

Evaluation : The automatic BP reading should have reduced observer error. The preparation of the child for the procedure and use of the mean of two readings should reduce intra-individual variability. Height and weight (ponderosity index) were controlled in the analysis, however, age effects and arm (cuff) size were not addressed.

Judging Causal Significance:

Strength of the Association: Regression coefficients not reported, but the multivariate F for the effects of noise on systolic and diastolic BP was significant at $p < .05$.

Statistical Methods: Regression analysis.

Temporal Relationship: Not determinable from cross-sectional data.

Dose-Response Relationship: BP increased with years of exposure (defined as years enrolled in school), but the age effect must be considered since this increase is greater in the quiet school subjects than in the noise school sample.

Control for Potential Confounders:

While the narrative reports that noise schools were matched with quiet schools at each grade level, the variables ponderosity, ethnicity, SES, race, and mobility were not controlled in the design but in the analysis phase. Age of child was not stated as a study variable. It may not be possible to separate age effects from exposure defined as years enrolled in school. Air pollution values were below established standards in all school districts. Children with hearing losses were excluded from study.

Conclusions:

Authors : "...Thus children from noisy schools have higher blood pressure and are more likely to give up on a task than children from quiet schools are....The only evidence for an adaptation effect is provided by the systolic blood pressure data. On that measure, the greatest difference between the noise and quiet groups occurred during the first 2 years of exposure. As length of exposure increased, these differences leveled out but still remained substantial....Replications of these results in other settings and with other populations are required before definitive conclusions are possible."

Overall Evaluation:

This cross-sectional study, controlling for major confounding variables except perhaps age, appears to be methodologically sound. Results are supportive of a positive association between noise exposure and BP level in children. The mean blood pressures for all children were low relative to those observed in other studies. The major weaknesses of the study are those inherent in all cross-sectional designs.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 9
Epidemiologic Method = 6

Citation: Cohen, S., Krantz, D.S., Evans, G.W., Stokols, D. and Kelly, S.: Aircraft Noise and Children: Longitudinal and Cross-Sectional Evidence on Adaptation to Noise and the Effectiveness of Noise Abatement. Journal of Personality and Social Psychology 40(2): 331-345, 1981. (English)

Researchers and Institution where research performed:

Cohen - University of Oregon;
Krantz - Uniformed Services University of the Health Sciences;
Evans, Stokols, and Kelly - University of California at Irvine.

Stated Purpose: To examine the course of adaptation and the impact of noise-abatement intervention on a variety of physiological, cognitive, and motivational measures.

Study Design and Sample:

: Community survey of school children.

: Combination of cross-sectional and longitudinal design. Longitudinal data were analyzed to determine if noise effects increased or decreased over the one year interval (1977-1978). Separate cross-sectional and longitudinal analyses were used to evaluate the effectiveness of noise-abatement interventions. The cross-sectional data were collected during the first testing session and compared children who were in noise-abated classrooms with those in noisy (non-abated) rooms as well as those who were from quiet schools; the longitudinal analyses looked at changes in the response of children who moved from a noisy to a noise-abated classroom in contrast to those exposed both years in noise-impacted rooms.

: At initial session 1977 sample consisted of 142 children in noise exposed schools and 120 in quiet schools; at one year follow-up - 83 children in noisy schools and 80 in quiet; for noise abatement, sample consisted of 44 children in noisy rooms at both testings and 39 who were in noisy rooms at first testing and abated rooms during second testing.

: All children (without hearing impairment at > 25 dB in either ear at 500, 1000, 2000, 4000 Hz) in the third and fourth grades at the four noisiest schools in the air corridor of Los Angeles International Airport, with an equivalent number of classes from three quiet schools group matched on ethnic and racial distribution, % receiving AFDC and occupational and educational level of parents.

Data Sources : Direct measurement of subject variables and classroom noise levels; noise contours were compiled by the Los Angeles International Airport for sound levels outside the home of noise-school children.

Bias Potential in Design:

: Self-selection into schools or school district and into sample (subjects absent on day of testing were not tested).

: Attrition bias - failed to follow-up 38% of sample; 33% lost to follow-up in quiet schools and 42% lost to follow-up in noisy schools.

: Ecological fallacy.

: Information bias - were children "blind" to the purpose of the study or were children in noisy schools likely to be induced to give different responses on the questions knowing the effects of noise were being studied.

Noise Exposure:

Noise Description:

Source : Aircraft overflights.

Type : Aircraft noise, nonsteady.

Frequency Composition: Not reported.

Levels : Mean peak noise level for noisy classrooms at T_1 = 79.06 dB; mean peak noise level for abated classrooms at T_1= 63.17 dB; mean peak noise level for quiet classrooms at T_1 = 56.60 dB; at T_2 noise levels were:

	L_{eq}	L_{33}	Peak dB(A)
noisy classroom	70.29	55.82	91.50
abated classroom	62.82	49.27	71.27

Duration of Exposure: 300 overflights a day with one flight every 2½ minutes during school hours (number of hours not reported). Actual exposure of each child is questionable.

Instrumentation: At testing session T_1: Tracoustics Sound level meters (SLM S2A) and testing session T_2: Digital Acoustics (DA 605), B & K (4426), General Radio (1945) NLA, calibrated.

Measurement Procedure: T_1 - interior sound levels were measured inside each classroom; T_2 - microphones placed approximately 3 feet from ground in center of room. "A" scale used. Noise level average on an energy basis each hour period (L_{eq}). Compliance with standards not reported.

Environment : Uncontrolled; classrooms; noise monitored in center of classroom; relationship of children to point of measurement not described.

Subjects : History of noise exposure after school hours was not reported. No information regarding history of ear disease and otological examinations. Hearing screening performed at 500, 1000, 2000 and 4000 Hz at 25 dB.

Evaluation : Study fails to provide adequate data on subject characteristics. Frequency composition of noise is lacking and actual durations of exposures and levels of exposure are questionable.

Health Effects:

CVS Response : Mean of single BP measurements taken on two consecutive testing days; coders blinded to experimental condition; automatic BP recorder (SR-2 Physiometrics), allegedly validated in Louisiana Study, used; BP taken in a quiet room.

Tested first in spring 1977 and again in spring 1978. Absenteeism was used as an indirect health outcome.

Evaluation : Automated BP allowed graphic display to be coded, thus observer error should have been controlled. On the first day of testing, BP was taken but not recorded to allow children to adapt to the procedure. It is unclear as to whether or not child's time in the testing room was controlled and the relationship of BP reloading to the "testing" measurements. Weight and height were controlled in the analysis.

Judging Causal Significance:

Strength of the Association: Regression coefficients not reported, but no effects of noise, testing session, or any of the interactions on SBP or DBP were observed.

Statistical Methods: Regression analysis.

Temporal Relationship: No significant differences of BP were observed at retest for noise-exposed children who had experienced a year in a noise-abated classroom compared to the continuously noise-exposed. However, the sample size was very small and comparisons were not made with quiet classroom children because of the "conceptual problem of evaluating change scores when initial scores are significantly different."

Dose-Response Relationship: None noted. There were no differences between the noise and abated groups for either SBP or DBP.

Control for Potential Confounders:

Group matching and a statistical regression approach allowed control of hearing sensitivity, grade level, ethnic and racial distribution, % of families on AFDC, occupational and educational level of parents, and number of children in school. It is unclear whether or not age of child was included as a demographic variable. The observed increase in BP with years of enrollment suggests a possible age effect since it was greater in children from quiet schools.

Conclusions:

Authors : "...Noisy-school children who were not retested had higher blood pressures than those who were retested; whereas being retested was unrelated to blood pressure for quiet-school children....(BP) Although the analysis of the complete T_1 sample indicated inflated systolic and diastolic blood pressure for noise-school children, there were no effects of noise, testing session, or any of the interactions on either systolic or diastolic blood pressure in the present (longitudinal) analysis. Longitudinal blood pressure effects were not expected, however, since a relatively high proportion of noisy school children with high blood pressure were lost to attrition...." "The data reported in the analyses of the entire T_1 sample indicated effects of aircraft noise on cognitive, motivational, and physiological mechanisms that were consistent with effects found in laboratory settings. The data presented in this article established the stability of these effects over time. Moreover, they reinforce our interpretation of the earlier cross-sectional data that children do not adapt to noise over time. The analyses of noise-abatement effectiveness indicate that the abatement is partially effective, with important school achievement measure showing some improvement for children in noise-abated classrooms....these data suggest that noise insulation in the classroom may not be enough..."

Overall Evaluation:

The strengths of this study are its initial cross-sectional design with specification of multiple potential confounding variables and the statistical methodology applied. Unfortunately the sample attrition bias, recognized and described in detail by the investigators, severely limits the inferences that may be drawn from the longitudinal analysis relative to the impact of noise on blood pressure.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 9
Epidemiologic Method = 7

Citation: Cuesdean, L., Teganeanu, S., Tutu, C., Raiciu, M., Carp, C. and Coatu, S.: Study of Cardiovascular and Auditory Pathophysiological Implications in a Group of Operatives Working in Noisy Industrial Surroundings. Physiologie 14(1):53-61, 1977. (English)

Researchers and Institution where research performed:
Outpatient Clinic of the Ministry of Chemical Industry, "Caritas" Hospital, Bd. Hristo Botev 21.

Stated Purpose: To study cardiovascular and hearing disorders in operatives working in the noise of a rubber plant.

Study Design and Sample:
: Workers in chemical industry not exposed to toxic substances.
: Cross-sectional with 160 subjects working in intense, permanent noise and 160 subjects not exposed to noise.
: No indication as to how sample was selected, nor of the completeness of sample.

Data Sources : Primary clinical examinations, audiometry. No information as to whether data was collected in a blind manner.

Bias Potential in Design:
: Selection; selective survival; selective recall - the noise exposed group may have been more likely to associate their environment with real or perceived stress than the non-exposed.
: Duration of noise exposure and employment not necessarily similar across occupational groups. Sample size not adequate for stratifying by sex.

Noise Exposure:
Noise Description:
Sources : Chemical industry, identified by occupation rather than actual source (stokers, air-compressor operatives, mechanics, electricians, lab assistants).
Type : "Chemical industry," industrial environment.
Frequency Composition: 63-8000 Hz, too general regarding the number of noise sources involved.
Levels : 85-106 db, but varied by occupational group: air-compressor operators, 100-106 db; stokers 100-106 db; mechanics, 95-100 db; electricians, 90-95 db; lab assistants, 85-95 db. Industrial noise exceeded CZ 85 curve by 13 db at 1000 Hz, 10 db at 2000 Hz, 9 db at 500 Hz, 4 db at 4000 Hz and 1 db at 250 Hz.
Duration of Exposure: "Mean" duration of 6 years in 21-40 year old group; and 10 years in 41-60 year old group.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled; industrial.
Subjects : History of vocational exposure at the chemical plant given; hearing thresholds obtained after exposure only; history of avocational noise exposure, ear disease, etc., not given.

Evaluation : Poor regarding noise parameters and controls. Authors could not state with certainty whether a worker was actually exposed consistently to the noise levels reported. Noise measures very general relative to the variability of the industrial group.

Health Effects:

CVS Response : Hypertension is not clearly defined, but is probably ≥ 140/90; in the noise exposed group, 13 had BP ≥ 140/90 before work and only 4 had elevated BP after work. In the non-exposed group, 4 had BP ≥ 140/90 before work with all returning to normal values after work. But Table 3 shows 4 cases in each group of "arterial hypertension Stage I undefined."

: Neurocirculatory asthenia as a health outcome was not defined. 31.25% of the noise exposed group and 13.75% of the non-exposed experienced this problem.

: ECG alterations with significant differences in elevated voltage (3-1, 3-3) in lateral leads and in ST segment depression at junction with upward sloping (4-4).

Evaluation : Hypertension not clearly defined. Usual definition of neurocirculatory asthenia is "anxiety neurosis" which is not a cardiovascular disease and there is no known evidence of increased organic heart disease in association with this.

: ECG alterations - significant differences:

-Elevated voltage (3-1, 3-3) in lateral leads is seen in left ventricular hypertrophy, but criteria of Minnesota Code is very non-specific for disease (affected by age, physical size, obesity, etc.)

-ST segment depression at junction with upward sloping (4-4) is not a pathologic measurement. Probably normal especially in short PR interval.

-ST elevation (9-2, 9-2-1) is a common "normal variant" clearly more common in healthy athletic muscular individuals. There is no known clinical evidence of associated disease, nor evidence that it represents a coronary risk factor.

-"Counter-clockwise rotation" - shift of QRS transition to right (9-4-1) has no definite meaning and may be related to differences in physical build.

: Some of the differences that may be due to body build and physical activity are seen between subgroups within noise group, i.e., air-compressor operators and laboratory assistants.

: Although health effects (ECG changes) are "significant" statistically, it is not clear that these are of any clinical significance.

Judging Causal Significance:

Strength of the Association: None reported.

Statistical Methods: None provided. Data presented in univariate manner in percentages. Although a control group of 160 industrial workers not exposed to noise was described, it is not clear that appropriate comparisons were made.

Control for Potential Confounders:

Sex, age, SES, physical activity not adequately controlled. Although relative humidity, smoking, overweight and excess animal fat in diet were available, no cross-tabulations, stratification or multivariate analyses performed.

Conclusions:

Authors : "...permanent industrial noise on the cardiovascular system, disturbances on the borderline between normal and pathologic were detected....Statistical processing of the data indicates an increased frequency of ECG alterations at rest, classified according to the Minnesota Code 3-1, 3-3, 4-4, 9-2, and 9-4-1. Indices 3-1, 3-3 and 9-2 were more frequent among the men working in a medium of permanently intense noise. The highest incidence was that of upward deflection of segment ST, of the 'benign' type. The alteration detected might be assumed to evolve towards organic lesions."

Overall Evaluation:

Study design, sample selection and analyses were not described well. Associations between hearing loss and cardiovascular responses were not provided. Reliability and validity of the data are questionable. Although ECG changes are "significant" statistically, it is not clear that these are of any clinical significance as suggested by the researchers.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 2
Epidemiologic Method = 4

Citation: Dega, K. and Klajman, S.: The Effect of Noise on Some Indices of the Circulatory System Efficiency of Shipyard Grinders. Institute of Maritime and Tropical Medicine in Gdynia 28(3-4): 143-149, 1977. (English)

Researchers and Institution where research performed:
Institute of Maritime Medicine of the Military Medical Academy, Department of Hygiene, Gdynia, Poland.

Stated Purpose: To estimate the health hazard (based on analysis of indices of circulatory system efficiency) of shipyard workers concerned with propeller machinery, due to noise induced by this work.

Study Design and Sample:
: Occupational groups of men working at propeller grinding compared to similar shipyard workers not exposed to noise.
: Quasi-experimental - pre and post shift measurements taken on exposed and non-exposed subjects.
: Sample of 36 men, aged 23-42 (average age 31 years), working at propeller grinding for 1-14 years (average of 5 years), and 20 workers, aged 20-37 years (average age 29 years) with similar employment 1-10 years (4.5 years average) who were not exposed to noise.
: Completeness of sample and selection criteria not reported.

Data Sources : Not stated; assumed to be primary data collection.

Bias Potential in Design:
Potential for all bias inherent in prevalence data including selection bias.

Noise Exposure:
Noise Description:
Source : Pneumatic hammers and high speed grinders; hammers 10-20 dB more intense (on average) than grinders.
Type : Propeller grinding; variable, unsteady.
Frequency Composition: Variable; plotted on graphs for each test site for octaves 31.5 through 8000 Hz.
Levels: Noise levels at all stations exceeded N-85 curve. Plotted by dB per octave for 31.5 through 8000 Hz.
Duration of Exposure: Questionable, as authors report subjects working time was 1-14 years for eight hours daily.
Instrumentation: Typical Bruel and Kjaer set; model not reported, however B & K does meet standards.
Measurement Procedure: Difficult to determine whether "normalized regulations" in the statement "measurement of noise levels were carried out...during the normal course of work according to normalized regulations" refers to working procedures or noise measurements, but will presume it refers to noise measurement. Type of procedure and location of noise measurements - as at the ear of the workers or center of the room - not specified. Although acoustic analysis was performed, compliance with ISO standards is questionable due to lack of data to evaluate.

Environment : Uncontrolled worksites; individual propeller machining stations not described, however map of sites was drawn and acoustic background levels plotted.

Subjects : Propeller grinders had history of 1-14 years (5 years average) vocational exposure. Histories of avocational noise exposure, hearing thresholds, ear disease, otological examination, general use of ear protectors, etc. not reported.

Evaluation : Study rates high relative to plotting noise levels in work sites; however, it is not clear exactly where measurements were made, i.e., center of room or "at ear" location. No noise measurements were reported for areas where non-exposed workers were employed. Exposures of individual propeller grinders not reported. Noise levels vary from one site to another and workers have had varying times of employment. Histories of other possible noise exposures were not explored, nor were hearing or otological conditions checked.

Health Effects:

CVS Response : BP and heart rate; heart minute volume according to Starr's formula. Pulse rate and arterial pressure were measured previous to and after the eight hour working day.

Evaluation : Starr's formula is a derived parameter based on heart rate and BP. Either variable will change the parameter. Apparently the major change was in the heart rate but raw data are not available to check the significance. The method of BP measurement was not stated. Changes were bi-directional suggesting a variable response. The relationship of the parameter to disease is not known.

Judging Causal Significance:

Strength of the Association: A difference was observed in heart minute volume before and after the noise effect between exposed workers and the controls, but was not quantified. Although before-after work measurements were available it is not clear as to what extent these were used to differentiate between short-term and long-term changes.

: Prevalence data with findings consistent with several other investigators.

: Provides suggestive evidence of a dose-response relationship in that the heart minute volume showed a decrease to almost the level of the control group when 10 workers operating propeller grinders were examined while using individual anti-noise ear protectors.

Statistical Methods: Student's t-test to compare means of exposed and non-exposed groups.

Control for Potential Confounders:

Groups selected to be similar in age and time worked. No other evidence of controlling for potential confounders such as social class, weight, avocational noise exposures, etc.

Conclusions:

Authors : "In workers operating grinders, higher ocsillations in the heart minute volume were observed than in workers not exposed to noise...Appliance of simple anti-noise protective means reduces the effect of noise on the circulatory system of workers operating grinders.... The higher mean of the minute heart volume in persons exposed to noise was first of all connected with increase of the pulse rate.... The differences in heart minute volume determined according to Starr's formula before and after the noise effect, ranged from +2900 ml. to -1100 ml. (arithmetical mean +1740 ml.), and in those not exposed to noise, from +1680 ml. to - 830 ml. (arithmetical mean +1210 ml.)."

Overall Evaluation:

There is insufficient information to adequately judge the quality of this study. However, it offers an attractive design in that it makes pre- and post-measurements on an exposed and a comparison group. There is no evidence of control for confounding factors, quality of the measurements, etc. The study rates relatively high in regard to plotting noise levels in the worksites of the exposed or grinders; however no noise measurements were presented for the comparison or non-exposed group. The relationship of the parameter, heart minute volume, to disease is not known and data may better be analyzed as individual BP and pulse rate measures. The data are suggestive of a dose-response relationship in that exposed workers wearing anti-noise ear protectors experienced a decrease in heart minute volume similar to the level in controls.

(Scores on a scale of 0-9)

Noise Exposure = 5
Health Effects = 4
Epidemiologic Method = 4

Citation: di Cantogno, L.V., Dallerba, R., Teagno, P.S. and Cocola, L.: Urban Traffic Noise, Cardiocirculatory Activity and Coronary Risk Factors. Acta Otolaryng Suppl. 339:55-63, 1976. (English)

Researchers and Institution where research performed:
Department of Audiology and the 1st Department of Medical Pathology, University of Turin, Turin, Italy.

Stated Purpose: An assessment of the effect of road noise lasting 10' on cardiocirculatory activity and various blood chemistry indices, particularly those apparently associated with the pathogenesis of arteriosclerosis.

Study Design and Sample:
: Quasi-experimental design.
: Sample - four groups were compared (all males); 33 subjects aged 20-70 years exposed to road noise:
11 normal subjects, average age 36.7 years;
11 diabetics or dyslipaemic, average age 46.4 years;
11 coronaropathic, average age 52 years.
: 11 normal subjects, mean age 27 years, subjected to all experiments in absence of road noise.
: Data on sample size and selection not given.

Data Sources : Experiment.

Bias Potential in Design:
No attempts to select groups of equal age; no random assignment of normal subjects to exposed and control groups or patients to noise exposure and nonexposure. Sample size small.

Noise Exposure:
Noise Description:
Source : Uher 4400 Stereo Report I C recorder fed noise (tape recording) through an Amplaid 500 Audiometer, into headphones.
Type : Road traffic noise.
Frequency Composition: Not reported.

Levels:	L_m dB	L_{eq} dB	σ + dB
	88.8	89.4	2.35
	L_m dB(A)	L_{eq} dB(A)	σ + dB(A)
	71.6	73.1	3.54

Duration of Exposure: States 10 minutes (with ten one minute recordings used).
Instrumentation: "B and K phonometer fitted with a model 1613 octave filter" (also audiometer calibrated in dB SPL).
Measurement Procedure: Checked with B and K "phonometer"; did not mention whether an artificial ear was used to check earphone calibration.
Environment : Controlled; Amplifon G5 "silent booth" erected in a room lined with "soundproof panels".
Subjects : All subjects had "normal hearing for age", but "for age" was

not explained. History of vocational and avocational exposure, ear disease and otological exam not reported.

Evaluation : Study is good regarding reporting of noise parameters with the exception of frequency composition. Little information provided about subjects.

Health Effects:

CVS Response : BP automatically indicated every minute with an Erka Diasist apparatus; ECG and polygraphic data. Other measures were blood sugar, blood insulin, blood uric acid, total lipids, cholesterol, triglycerides and urinary catecholamines.

Evaluation : BP apparatus used probably detected phase 4 for diastolic; did not state how "coronary disease" or "dysmetabolic" was defined or subjects diagnosed; used standard systolic time intervals for cardiac functions and standard ECG techniques. Controls might have been better as unstimulated subjects. Ages of the controls were quite different (younger) from the experimental group. No statistical analysis or significance of changes from period to period noted.

Judging Causal Significance:

Strength of the Association: Not given. Experiment could only detect short-term responses. Observation that traffic noise was responsible for a distinct increase in the index of frequency times systolic pressure, in normal subjects, followed by a fall in response during the application of the acoustic stress is consistent with other studies.

Statistical Methods: Student's interval estimation with $p = 0.05$; for before-after comparisons some measure of intra-individual variability is needed.

Control for Potential Confounders:

There appeared to be no attempt to control for possible confounding such as social class, medications, previous noise exposure. Attempted to analyze for age effects, but failed to state how this was accomplished in such a small sample of diverse aged individuals.

Conclusions:

Authors : "We were particularly struck by the extent of the blood uric acid response, showing that noise has an effect on the metabolism of nucleic acids. As was to be expected, normal subjects generally presented less significant changes, especially in total lipids and triglycerides. An immediate increase in blood sugar was noted only in 50% of this group as opposed to 80% of the other's....The product of cardiac frequency and systolic arterial pressure - an index of change in coronary flow and the metabolic requirements of the myocardium - increased to a greater extent and for longer after the cessation of the road noise in the coronary patients, as was to be expected on theoretical grounds. This index tended to fall during the stimulation period in the normal subjects, whereas it stayed high throughout this period in the dysmetabolic group. This behaviour shows that exposure to traffic noise may be responsible for an increase in myocardial energy requirements by influencing frequency and systolic pressure."

Overall Evaluation:

This study is a quasi-experiment utilizing very small comparison groups (N = 11 each group) with no attempt to select groups of equal age and no random assignment of the normal subjects to acoustic stimuli or control group. Inferences made about techniques used are not explicit. Although the study is fairly good in reporting noise parameters, it addresses short-term noise exposures only.

(Scores on a scale of 0-9)

Noise Exposure = 6
Health Effects = 8
Epidemiologic Method = 3

Citation: Drettner, B., Hedstrand, H., Klockhoff, I., and Svedberg, A.: Cardiovascular Risk Factors and Hearing Loss: A Study of 1000 Fifty-Year-Old Men. Acta Otolaryngol 79(5-6):366-371, 1975. (English)

Researchers and Institution where research performed:
Department of Audiology, Otolaryngology and Internal Medicine, University Hospital, Uppsala, Sweden.

Stated Purpose: To search for possible correlations between hearing loss and cardiovascular risk factors, separate as well as in combinations.

Study Design and Sample:
: Community survey of healthy middle-aged men in the city of Uppsala.
: Cross-sectional study.
: Sample of 1000 men, aged 50, consecutively selected from a health examination survey; 388 reported history of noise exposure and 374 reported no history of exposure. 238 subjects were excluded because of possible conductive hearing loss.
: Sampling frame unknown.
: 83.9% participation rate.

Data Source: Survey.

Bias Potential in Design:
Self selection into sample and non-respondent bias; selective recall of noise exposure; potential for misrepresentation of the data with the repeated multiple correlations of all variables.

Noise Exposure:
Noise Description:
Source : Not identified.
Type : Not identified.
Frequency Composition: Not specified.
Levels: Not specified.
Duration of Exposure: Not identified.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Unknown.
Subjects : Subjects responded to a questionnaire with a "yes" or "no" regarding history of noise exposure. The authors note that most of the subjects who denied noise exposure had, nevertheless, had a period of military service in their past. Hearing was tested with a pure tone audiometer at 500, 1000, 2000, 3000, 4000 and 6000 Hz bilaterally. Threshold determinations down to 15 dB (ISO, R389) were possible in the testing room. Noise exposure was used as a possible CVD risk factor.
Evaluation : Noise parameters not identified. Not possible to identify a specific noise source which might have induced hearing loss. Because amount of hearing loss is expressed as the

sum of dB hearing loss of both ears at five frequencies (1000, 2000, 3000, 4000 and 6000 Hz), it is impossible to determine precise thresholds across frequency. Actual thresholds obtained in each ear would have yielded more useful information.

Health Effects:

CVS Response : Heart rate.

: BP measured after 10 minutes of rest in supine position.

: Serum cholesterol and triglycerides.

Evaluation : Quality control of data questionable; no specific criteria provided.

Judging Causal Significance:

Strength of the Association: None found.

Statistical Methods: Chi-square and Kolmogorov-Smirnov tests employed. Specific analysis unclear - apparently each variable was compared or correlated with every other possible variable.

Control for Potential Confounders:

Selection criteria for sample not stated. A set of correlations of 11 variables - unclear as to what may be considered a confounder.

Conclusions:

Authors : "The correlation studies between hearing loss...(and 10 risk factors including SBP, DBP, heart rate, smoking habit and noise exposure)...showed no significant correlations except for smoking habits....Among the 92 individuals who had smoked more than 10 cigarettes daily but had not been exposed to noise, the amount of rightsided hearing loss was significantly greater than in the 105 individuals who had never smoked and had not been exposed to noise....There was no correlation between hearing loss and cardiovascular risk factors."

Overall Evaluation:

Study poor in judging causality; correlational data produced results difficult to interpret. There was no definition of the noise parameter. Very little information was presented on analysis and results. This type of study may be of value in that hearing loss and noise exposure did not correlate with CVD risk factors such as high blood pressure, cholesterol, smoking, etc. when considered individually nor when a "high CVD risk profile" was examined. However, the "high risk" group was not especially high on BP, cholesterol and smoking.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effect = 7
Epidemiologic Method = 4

Citation: Frerichs, R.R., Beeman, B.L. and Coulson, A.H.: Los Angeles Airport Noise and Mortality - Faulty Analysis and Public Policy. American Journal of Public Health 70(4):357-362, 1980. (English)

Researchers and Institution where research performed:
Division of Epidemiology, School of Public Health,
University of California, Los Angeles, California.

Stated Purpose: To assess by reanalysis, the findings of a community-based investigation which attempted to link excessive deaths with community exposure to aircraft noise.

Study Design and Sample:
: Vital Records mortality study; cross-sectional data.
: By census count, population base of 64,801 in the test area within the 90 dBA contour created by the noise of the jet aircraft with 893 deaths reported; and 58,240 in the control area (45-50 dBA noise level) with 732 deaths reported.

Data Sources:
Mortality: Age, race, sex and cause-specific death occurrences for the test and control areas for 1970-1971 including only deaths which could be determined to have occurred in the designated census tracts. Change in census tract coding system created problems in determining deaths which occurred in the precise study areas.
Population: Age-race-sex specific population by census tract using 1970 Los Angeles County census tape, second count.

Bias Potential in Design:
Ecologic fallacy; temporal relationships; self-selection into test or control areas.

Noise Exposure:
Noise Description:
Source : Aircraft engines.
Type : Jet engines (unsteady).
Frequency Composition: Not specified.
Levels : Test area: within the 90 dBA noise contour (90 dBA or more). Control area: 45-50 dBA. No documentation as to whether levels were tested in yards, within homes, on streets, etc.
Duration of Exposure: Not reported.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled; neighborhood flown over by jet aircraft.
Subjects : No individual data reported; life styles, history of exposures, hearing thresholds, etc. not known.
Evaluation : Improper to draw conclusions based upon unknown noise levels. One would need to know the total exposure of each subject, including time shielded by enclosures such as a house or car.

Health Effects:

CVS Response : Deaths due to all causes and deaths due to major cardiovascular diseases (ICDA 390-448, 8th Revision) and cerebrovascular diseases (ICDA, 430-438) as coded by the State of California and characterized by age, race, sex.

Evaluation : Errors in diagnosis and reporting of deaths may be a problem, especially within specific diagnostic categories. However, deaths due to all causes would be subject to only minimal diagnostic error.

Judging Causal Significance:

Strength of the Association: Negative.

Statistical Methods: SMR.

Control for Potential Confounders:

Data adjusted for age, race, sex by both direct and indirect methods of standardization. Rates derived by carefully relating numerator and denominator data.

Conclusions:

Authors : "We were unable to validate the findings of Meecham and Shaw....Once the confounding effects of age, race and sex were taken into account by direct and indirect methods of standardization, there was little difference in the mortality experience of the airport and control areas. Adjusted mortality rates due to all causes, cardiovascular diseases, or cerebrovascular disease did not differ appreciably between the two areas....Clearly any link between airport noise and mortality must be based on sounder evidence than has been presented to date if causality is to be inferred."

Overall Evaluation:

This paper is an excellent treatment of the original paper by Shaw and Meecham and gives adequate attention to most epidemiologic concerns of mortality analysis. The review of the data by Frerichs, et al., indicates that there is no evidence for a noise effect after controlling for age/race/sex. As the authors point out, positive results would have been very difficult to interpret since differences in people who choose to live near an airport may differ from people who live elsewhere; these differences, rather than noise, may account for the observed differences. But these "negative" effects shown by Frerichs still suffer from noise exposure not well defined; an outcome (mortality) with problems of diagnosis, age on certificate, etc., and study design defects (ecological fallacy, length of exposure).

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method = 7

Citation: Friedlander, B., Grebermann, M., Wathen, G. and Zeidler, W.: An Analysis of Noise and Its Relationship to Blood Pressure in an Industrial Population. Manuscript, Maryland State Department of Health and Mental Hygiene (undated). (English)

Researchers and Institution where research performed:
Community Medicine, Maryland State Department of Health and Mental Health.

Stated Purpose: To test two hypotheses: (1) prolonged exposure to excessive noise levels causes a significant rise in arterial blood pressure; (2) there is a higher incidence of hypertension in male workers exposed to loud industrial noise over a prolonged period of time than in those workers exposed to a relatively low intensity of noise.

Study Design and Sample:

: Occupational groups of civilian employees of the Curtis Bay Shipyard, a part of the U.S. Coast Guard.

: Historical prospective study utilizing extant medical records; no evidence of identification of a specific cohort and no information presented regarding follow-up or tracing of a cohort.

: 441 subjects selected from 1783 medical records after the following exclusions: employment less than 5 years, hypertension diagnosed on first visit to clinic, inadequate blood pressure measurement, unsuitable work history (work history indicating noise exposure had been broken in 5 year peiod or work history not available), female, race not available, age less than 35 or not available on the medical record.

: The subjects were first grouped according to blood pressure data available: Group 1 - 143 persons who had BP readings within one year of initial employment and Group 2 - 298 persons who had their initial BP measurement at least one year after employment date or employment date unknown. Groups 1 and 2 were further subdivided according to noise exposure levels of (a) low noise, < 70 dB, office workers primarily; (b) intermediate noise, 70-79 dB, skilled workers employed the majority of the time in shops having a moderate noise intensity level; (c) high noise, > 80 dB, skilled workers intermittently exposed to loud noise on Coast Guard cutters and in shops. Subjects were categorized into age categories of 26-34, 35-44, 45-54 as of the first BP reading.

: No information provided regarding method of ascertainment of cohort; it is unlikely that medical records represent a complete cohort of workers at the Curtis Bay Shipyard; work mobility unknown.

Data Sources : Secondary data sources: extant medical records of civilian employees of the Curtis Bay Shipyard.

Bias Potential in Design:

Incomplete identification of an occupational cohort with no information as to noise exposure status at time of employment at Curtis Bay and no information that individuals "lost" to the medical services over the 5 years were traced to identify blood pressure status. Medical records in a Public Health Service dispensary are probably inadequate for identifying an occupational cohort since medical records of these employees are usually sent with the worker as he moves from job to job; no information on worker mobility is available. Comparability of low noise group (controls) consisting primarily of office workers to high noise groups of skilled workers is unlikely for personal and environmental factors.

Small and highly selected sample with potential for many exclusions based on missing data alone; measurement bias due to use of extant data; selective factors in relation to individuals seeking services suggested by fact that those who had blood pressures taken within first year of employment tended to have a higher proportion developing hypertension within the 5 years than those with no recorded blood pressures in the first employment year.

Noise Exposure:

Noise Description:

Source : Not reported; only indicate noise was measured in the various machine shops of the shipyard.

Type : Industrial; shipyard machine shops; steady or nonsteady not reported.

Frequency Composition: Not reported.

Levels : Measured noise levels not reported; low noise defined as < 70 dB; intermediate noise level as 70-79 dB and high noise level as > 80 dB.

Duration of Exposure: Actual durations not reported; all subjects had been employed at least 5 years.

Instrumentation: Not reported.

Measurement Procedure: Not reported, but states that approximate noise levels were obtained through a study done on the noise levels of the various machine shops by the Safety Department at Curtis Bay and by interviews conducted by the investigators with various shop foremen.

Environment : Uncontrolled; relationship of workers to noise sources not reported.

Subjects : All subjects had at least 5 years exposure "to high intermittent noise"; other vocational and avocational noise exposures not known. History of ear disease not reported. Hearing thresholds obtained before study but when available were used to look at audiometric data at 500, 1000, 2000 and 6000 cps (Hz) to date of recording.

Evaluation : Study is poor relative to the identification of noise parameters. Actual noise levels, frequency composition, instrumentation and measurement procedures were not reported. Subject information lacking and noise environment not described.

Health Effects:

CVS Response : Blood pressure; elevated systolic blood pressure defined as > 140 mm Hg. and elevated diastolic pressure as > 90 mm Hg. Individuals with hypertension (DBP ≥ 95 mm Hg.) on the first clinic visit were excluded. Data collected from extant medical records; no more than 13 blood pressures extracted from one record.

Evaluation : With use of medical record data standardization of blood pressure readings is unlikely and there is an unknown quantity of missing data. No information provided as to how multiple and varying numbers of blood pressure readings were treated in identifying new cases of hypertension. Discrepancies between definitions for exclusions by age (<35 years excluded) and age stratified blood pressure findings (25-34 years). Comparability of Groups 1 and 2 on factors such as other diseases, family history of hypertension, obesity, stress, environmental conditions of temperature and humidity are unknown and uncontrolled.

Judging Causal Significance:

Strength of the Association: Relative risks reported for each race-age group; for total Group 1 ages 35-44, the relative risk was greater than 3; there was 2.76 times the risk for developing increased diastolic pressure in the high noise population as compared to the low noise population and 6.36 times the risk for developing increased systolic pressure in the high noise as compared to the low noise group. Authors report that although numbers were small, there was a noticeable trend toward elevated diastolic and systolic arterial pressures in groups exposed to high noise levels for 5 years. However, statistically significant differences in systolic pressures reported only for 35-44 year olds.

Statistical Methods: Method for determining risk ratios not given; traditional Chi-square with Yates correction and Cochran's Chi-square employed. Intermediate and high noise groups combined for analysis. Did not analyze hearing sensitivity data. No raw data or mean blood pressures presented; comparisons presented in graph form only, accompanied by table of relative risks.

Control for Potential Confounders:

Data stratified on race and age (all male group). No evidence of controlling for other potential confounders such as family history of hypertension, obesity, other stress factors in environment, social class, physical exertion of work, other diseases present, etc.

Conclusions:

Authors : "The data presented indicates that with prolonged exposure to loud noise of an intermittent nature there is a trend towards both elevated systolic and diastolic pressure when compared to a control population exposed to relatively low-noise intensity: that the relative risk for developing hypertension is greater in those exposed to prolonged loud noise than in controls matched for age and race." Study needs follow-up with close examination of the trends found.

Overall Evaluation:

Although this ostensibly historical prospective study reports a trend toward the development of elevated blood pressure among workers exposed to high noise for 5 years as compared to workers exposed to low noise, it suffers from severe methodological problems. The occupational cohorts were incompletely defined and followed, the sample was small and highly selective, multiple confounding variables were not controlled, the noise exposure and health variables were inadequately defined and measured, and analysis was incomplete. Communication with the senior author while attempting to locate the report of this study indicated that this investigation was a pilot project conducted by a group of summer students with the Maryland Health Department and was intended to be exploratory, capitalizing on data readily available. It is judged by the reviewers that this report should be considered as just that, an unpublished exploratory student project.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 6
Epidemiologic Method = 5

Citation: Gibbons, S.L., Lewis, A.B., and Lord, P.: Noise and Vibration on Board Ship. Journal of Sound and Vibration 43(2):253-261, 1975. (English)

Researchers and Institution where research performed:
Department of Pure and Applied Physics, University of Salford, Salford, England.

Stated Purpose: To confirm the results of controlled laboratory experiments demonstrating that measurable physiological changes occur in the presence of stressful stimuli (noise) and that these physiological parameters correlate well with the subjective assessment that a person makes of the stimulus.

Study Design and Sample:

: Officers on board four oil tankers.

: Quasi-experimental design; each officer served as his own control with data collected while on board ship and exposed to noise and while on leave or unexposed. Subjects were selected from four tankers ranked according to noise and vibration levels (NVR).

: Sample of volunteer officers on four oil tankers.

: Number of subjects from each tanker (exposure area) not given but samples must be small since author states "number of officers on any one ship rarely exceeded twenty and was often less".

Data Sources: Primary data collection of 24 hour urinary 17-ketosteroid levels and noise and vibration measurements.

Bias Potential in Design:
The volunteer officers may respond differently to noise than those who failed to volunteer. Sample size is not stated but is variable among ships suggesting that the non-equivalent groups may greatly reduce the equivocality of interpretation over what is obtained in a true experiment.

Noise Exposure:
Noise Description:
Source : Oil tanker noise on four ships; more specific sources not identified.
Type : "Objective noise" from tankers, steady or unsteady not reported.
Frequency Composition: Not reported, but information was recorded on tape to be frequency analyzed in the laboratory.
Levels: Noise not reported as such but rather "NRV" values to represent the total acoustic environment of noise and vibration were used. The NRV values ranged from 49 to 94 dB.
Duration of Exposure: Not reported.
Instrumentation: "High quality, fully portable equipment"; no data as to type, make or model, or compliance with standards.
Measurement Procedure: Not reported; measurements were taken at points of interest to ship's operators.
Environment : Uncontrolled; layout was not reported although it is very important relative to noise sources and subjects who worked in such areas as workshops, wheelhouse and a maneuvering

platform. Worker-noise source relationship poorly described.

Subjects : No information provided as to history of vocational exposure, avocational exposures, hearing thresholds, history of ear disease, etc.

Evaluation : The study combined the effects of noise and vibration as a total acoustic environment, for NRV values. Janssen (1969) was referenced relative to defining the NRV. How and precisely where measurements were made was not clear. It is impossible to assess the effects of noise alone on the basis of the design of this study.

Health Effects:

CVS Response : 24 hour urinary 17-ketosteroid levels and urinary volumes.

Evaluation : Methodology for determining 24 hour ketosteroid measurements was not given. Data were not provided as to control of adequate urine collections based on creatinine excretion, factors changing urine output related to intake and insensible loss related to humidity. The number of samples and individuals as well as the time during the "cruise" sampling occurred were not described for the reader. Control and "experimental" periods were not comparable because of variability in heat, activity, physical location, etc.

Judging Causal Significance:

Strength of the Association: Not reported.

Temporal relationship of long term exposure to noise and change in 17-ketosteroids unclear since duration of exposure and sequence of testing were not given. Somewhat of a dose-response relationship between decrease in 17-ketosteroids and NVR values when the data were ranked by ship. This must be viewed with caution since within each ship there were many localized areas of high and low noise and vibration.

Statistical Methods: Wilcoxon matched pairs test was used to compare the control and experimental sets of data.

Control for Potential Confounders:

No data provided on comparability of subjects on the four ships. The study design is too sketchy to determine if subjects were randomized to test and control situations, but randomization is unlikely.

Conclusions:

Authors : "The four ships were ranked according to NRV...and this ranking ties in very well with ranked physiological response in terms of 17-ketosteroid changes." (decrease) "Inspection of the median 17-ketosteroid levels from the crews of the four tankers indicated that the control values obtained when the men were on leave had returned within the range obtained from workers not exposed to noise. This suggests that officers recover from the ship's environment whilst on leave."

Overall Evaluation:

This study is difficult to assess because of its lack of attention to reporting pertinent details relative to design, noise and vibration measurement and physiologic measures. Sufficient data are not given to suggest that officers recover from the ship's environment while on leave. Noise and vibration treated as separate ratings, if possible to measure independently, may have been more informative.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 2
Epidemiologic Method = 3

Citation: Graeven, David B.: The Effects of Airplane Noise on Health: An Examination of Three Hypotheses. Journal of Health and Social Behavior 15(4):336-343, 1974. (English)

Researchers and Institution where research performed:
California State University, Hayward, California.

Stated Purpose: To examine three hypotheses of the effects of exposure, awareness and annoyance reactions to airplane noise, and cognitions about airplane noise on health problems.

Study Design and Sample:

: Cross-sectional community survey employing a quota sample of 20% of the females from each of four areas in the exposed city and a quota sample from selected blocks within a control city.

: Sample size - 552 with 169 from area one (the highest noise area), 96 from area two, 98 from area three, 88 from area four, and 101 from the control area.

: Selection of sample and response rate not given.

: Analysis revealed no systematic relationship between age, family income, educational background and length of residence in the community and the noise exposure areas.

Data Sources : A self-administered questionnaire distributed by field workers sponsored by the Sociology Department. Source of data on noise exposure not provided.

Bias Potential in Design:
Potential for self selection into study; the noise exposure areas differed in time in the home with persons who lived in the less exposed areas spending more time in the home than those persons who lived in the high noise exposure areas suggesting a potential for ecologic fallacy in interpreting findings. No individual exposures were available.

Noise Exposure:
Noise Description:
Source : Airplane noise.
Type : Unsteady.
Frequency Composition: Not reported.
Levels: Not reported specifically. City was divided into four noise impact areas according to the degree of exposure as measured with the Noise Exposure Forecast (NEF). Area one > 40 NEF; area two = 35-40 NEF; area three = 30-35 NEF and area four < 30 NEF. The control area was not within the flight path of a major airport.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Used NEF which apparently complied with guidelines; however, it is not clear whether the actual measurements were made by the author or whether he used airport maps of NEF areas.

Environment : Uncontrolled; neighborhoods either exposed or not exposed daily to airplane noise.

Subjects : Females were selected "because they would be in the home a greater portion of the time and thus would have a higher level of exposure to airplane noise." History of individual vocational and avocational noise exposure, ear disease, otological examination and hearing threshold data were not reported.

Evaluation : Study fails to explore the exposure environments with precision. Neighborhood noise in addition to airplane flyovers was not considered. It is unclear as to whether the actual noise measurements were made by the researcher or whether airport maps of NEF areas were used and if those measures reflect outside or inside the home. The actual noise exposure levels for subjects were not known. Thus, the study is lacking in respect to noise parameters.

Health Effects:

CVS Response : No specific measures with confirmatory diagnostic tests employed. Health state assessed with a self-administered symptom checklist interpreted by the researcher as measuring both psychological anxiety and physical health problems.

Evaluation : The general nature of the data while including several cardiovascular symptoms contributes little to the understanding of cardiovascular response to airplane noise.

Judging Causal Significance:

Strength of the Association: For the hypothesis of interest, the correlation between the level of exposure to airplane noise as measured by the five noise areas and the number of health problems was in the hypothesized direction, but was not significant (r = -.03).

Statistical Methods: Stepwise regression for the total sample and separate regressions for the five different noise exposure areas.

Control for Potential Confounders:

One would assume that several major variables were not adequately controlled in the analysis on the basis of the following statements: "The fact that the demographic variables were not related to the noise exposure areas provides support for the research design, and allows for the interpretation of the relationship between the noise exposure areas and health problems as due to the level of airplane noise."..."the latter comparison [correlations within the four exposure areas] was examined because there were some differences between the exposed areas and the control city that could account for the greater number of health problems in the control city. One difference was that control city respondents were somewhat older than persons in the exposed city (29 percent were over 50 years of age as compared to 12 percent in the exposed city)."

Conclusions:

Author : "...exposure to airplane noise was the third most important factor in determining health problems."..."The social and psychological approach contributed to a fuller understanding of the relationship between exposure to airplane noise... This conclusion is based on the fact that awareness and annoyance reactions to airplane noise were much more important in determining health problems than the level of exposure to airplane noise."

Overall Evaluation:

For our purposes, the negative findings of this study relative to exposure to airplane noise and reporting of symptoms must be interpreted with caution because (a) the very subjective measure of health may not reflect any cardiovascular response, (b) exposure to noise is poorly documented, and (c) controlling for potential confounding variables such as age was not apparent.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method = 3

Citation: Hannunkari, I., Jarvinen, E. and Partanen, T.: Work Conditions and Health of Locomotive Engineers: II. Questionnaire Study, Mortality and Disability. Scand. J. Work Environmental Health 4 (Suppl. 3):15-28, 1978. (English)

Researchers and Institution where research performed:
Institute of Occupational Health in Helsinki, the Finnish Union of Engine Drivers and the Finnish State Railways, 1975.

Stated Purpose: "The primary objective was to pinpoint the needs for improvement in work conditions and occupational health care....This article presents the results of...the questionnaire study on work conditions and health and the analysis of mortality and disability." Implied hypothesis was that different working conditions, including noise, were associated with differences in mortality and disability.

Study Design and Sample:
: Locomotive engineers (drivers and assistants).
: Two stage design: (1) cross-sectional study of 437 active engineers and 183 retired engineers; (2) historical prospective mortality/disability study of three groups: engineers, other trainmen and railroad clerks. Clerks and trainmen used as reference cohorts.
: Sample of all engineers employed on December 1, 1955 (N=4347? or 437); every 2nd trainman employed on December 1, 1955 (N=1575) and all railroad clerks employed on December 1, 1955 (N=1224).

Data Sources: Questionnaire data and mortality data from medical records.

Bias Potential in Design:
Ecological data in that individual exposures were not determined. Selection bias unknown.

Noise Exposure:
Noise Description:
Source : Locomotive engines.
Type : Railroad locomotive engines, unsteady (variable).
Frequency Composition: Not reported.
Levels: Variable; 45% of the measured equivalent noise levels exceeded 85 dB(A) during measuring period of 0.5 - 2 hours in the hygienic survey of locomotive cabs.
Duration of Exposure: "Irregular work hours", but fairly good attempt to estimate exposures on basis of schedules. In the mortality and morbidity analysis, the follow-up period from December 1, 1955 - December 31, 1973, implies a possible eighteen year exposure.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; locomotive cabs may have different dimensions and acoustic characteristics; noise will vary with position of worker in cab.

Subjects : All vocational exposures not reported. Railroad exposures, though intermittent, were estimated in a fairly good manner by work schedule histories. Hearing of workers was monitored routinely; deafness reported in five cases, however, ear disease histories were not explored. Otological examinations and history of avocational noise exposures were not reported.

Evaluation : Study is weak relative to specification of amount of actual noise exposure experienced on the part of each subject. Noise exposure was variable - exposure could have varied relative to the worker in locomotive cab and time on the job. Frequency composition of noise not reported and actual exposure questionable because measuring instruments and techniques were not specified.

Health Effects:

CVS Response : Illness diagnosed by physician included hypertension, coronary infarction, other heart disease, hearing problems, etc. as reported by subjects; mortality due to diseases of circulatory system.

Evaluation : No criteria for disorders of the circulatory system relative to disability and mortality given; sources of mortality data not stated; terminology and criteria for physician diagnosed disease not stated. Vibration, working hours, responsibility "stress" may be major confounding factors.

Judging Causal Significance:

Strength of the Association: Not given.

Statistical Methods: Tests employed, not given. Although reported that morbidity and mortality from cardiovascular disorders were higher among engineers than clerks and trainmen, statistical significance is not clear. Researchers state "the fact that engineers had the highest mortality in all five age groups is a sign of statistically significant evidence without further, more powerful tests."

Control for Potential Confounders:

Reported and measured vibration levels and temperature varied among the locomotive cabs and was not considered in the health effects analysis. Other potential confounders such as age, previous exposure, hearing loss, comorbidities, etc., not statistically controlled in the analysis.

Conclusions:

Authors : "The evidence on the relatively high risk of diseases of the circulatory system and tumors of the engineers during the follow-up period was, as summarized, well established.... According to the results of the study, technical improvements which lower noise and vibration [are recommended]."

Overall Evaluation:

Although exposure varied over time among engineers, the mortality analysis is suggestive of an association between noise and CVD. Further analysis with statistical control of major potential confounding variables is needed.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 0
Epidemiologic Method = 5

Citation: Hedstrand, H., Drettner, B., Klockhoff, I., and Svedberg, A.: Noise and Blood Pressure. Lancet 2:1291, 1977. (English)

Researchers and Institution where research performed:
Departments of Audiology, Otolaryngology and Internal Medicine, University Hospital, Uppsala, Sweden.

Stated Purpose: Not given, replication of Jonsson and Hansson study implied.

Study Design and Sample:
: Community survey.
: Cross-sectional comparison with noise-induced hearing loss versus other men. No details given.
: 2202 men aged 49-50 of which 393 fulfilled the noise-induced hearing loss criteria and 376 had normal audiograms.

Data Sources : Not given, previous study referenced is a community survey, but industrial noise is implied.

Bias Potential in Design:
Those inherent in cross-sectional data; hypertensives and hearing impaired may have retired, changed jobs, etc., earlier than those with no problems; baseline blood pressure and hearing loss readings not available.

Noise Exposure:
Noise Description:
Source : Industrial noise implied; noise-induced hearing loss used as a surrogate noise measure.
Type : Not specified.
Frequency Composition: Not specified.
Levels: Not specified.
Duration of Exposure: Not specified.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled.
Subjects : Hearing thresholds apparently measured after noise exposure. Noise induced hearing loss defined as $\geq$ 65 dB at 3000, 4000 or 6000 Hz and normal tone audiograms as < 20 dB at all frequencies.
Evaluation : Study lacking in all areas of noise exposure - noise description, noise measurement, environment, instrumentation and information regarding subjects.

Health Effects:
CVS Response : BP measured in supine position. Hypertension defined as $\geq$ 160/100 mm. Hg.
Evaluation : Definition of hypertension satisfactory. No further data given.

Judging Causal Significance:
Strength of the Association: None observed.
Statistical Methods: Not stated; means and s.e. given for normal and impaired hearing group.

Control for Potential Confounders:

Age and sex controlled; no controls for co-morbidities, etc.

Conclusions:

Authors : "The table shows the mean BP's in the two groups together with the prevalence of hypertension (supine ≥ 106/100 mm Hg). No significant differences were found. This accords with the negative report by Dr. Takala and others."

Overall Evaluation:

A surrogate measure of noise exposure is used. Evaluation is difficult because of limited information. However, a correlation between degrees of hearing loss and blood pressure may have been informative. This appears to be a reanalysis of a previous set of data published in 1975 (Acta Otolaryngol 79(5-6):366-371).

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effect = 3
Epidemiologic Method = 3

Citation: Jonsson, Anders and Hansson, Lennart: Prolonged Exposure to a Stressful Stimulus (Noise) as a Cause of Raised Blood-Pressure in Man. The Lancet 1(8002):86-87, January 8, 1977. (English)

Researchers and Institution where research performed:
Jonsson - Volvo, Inc., Gothenburg, Sweden.
Hansson - Department of Medicine I, Sahlgren's Hospital, Gothenburg, Sweden.

Stated Purpose: To determine whether a permanent rise in blood pressure had occurred in individuals exposed to noise severe and prolonged enough to cause an irreversible loss of hearing.

Study Design and Sample:

: Cross-sectional design comparing noise-induced hearing loss group versus normal hearing group.

: Sample of 196 male industrial workers tested for hearing loss on routine examination and divided into three groups:

1. Noise-induced hearing loss	44	
2. Normal hearing	74	
3. Miscellaneous types of hearing loss	78	(eliminated from study)

: Completeness and representativeness of sample unknown.

Data Sources : At routinely performed health examination, audiometric test and BP data collected.

Bias Potential in Design:
Diagnostic suspicion bias may be operating - knowledge of individual's exposure to noise in the industry may have influenced BP readings and audiometric tests even though the specific purpose of the investigation was not known to observers.

Noise Exposure:
Noise Description:
Source : Not specified, only indicated industrial noise.
Type : Not reported as to steady or unsteady.
Frequency Composition: Not described.
Levels: Not described.
Duration of Exposure: "Repeated and prolonged exposure", not described further.
Instrumentation: Not stated.
Measurement Procedure: Not stated.
Environment : Uncontrolled, not described.
Subjects : Noise induced hearing loss defined as a loss of acuity amounting to 65 dB or more at 3000, 4000 or 6000 Hz. No data as to history of vocational or avocational noise exposure, hearing thresholds prior to study, ear disease, hearing conservation program participation, etc. History of noise exposure alluded to as "prolonged."
Evaluation : Inadequate relative to noise exposure factors. Noise not described. Loss of acuity at 3000 Hz used in definition of hearing-loss groups, but hearing only tested at 250, 500, 1000, 2000, 4000, 6000 and 8000 Hz.

Health Effects:

CVS Response : One measure of BP in recumbent position after 15 minutes rest; data collectors unaware of purpose of investigation.

Evaluation : Inadequate as a chronic effect measure. No quality control of observers stated. BP measured to "nearest 5 or 10 mm. Hg." is not a standard procedure, not precise. No data given as to health of subjects, previous BP status or duration of elevated BP, medications taken. Strict criteria of hypertension (160/100) used.

Judging Causal Significance:

Strength of the Association: None given, but relative odds (R.O.) with C.I. could have been calculated; hypertensive status of 78 excluded subjects with R.O. would have been informative in determining whether or not a gradient of risk was present.

Statistical Methods: Student's t-test used to compare BP in hearing loss groups. Chi-square used to compare number of hypertensives in groups.

Control for Potential Confounders:

Potential biases not addressed were: response or completeness of group; reliability/validity of hearing and blood pressure measure; age effect; healthy worker effect - only included men working at time of study; antecedent-consequence relationship between hearing-loss and BP elevation. Groups were shown to be comparable as to mean age, but no evidence of controlling for age.

Conclusions:

Authors : Average blood pressures were significantly higher ($p > .001$) in industrial workers with a noise-induced loss of hearing than in workers with normal hearing and the proportion of hypertensive subjects were significantly higher ($p > .05$) in the group with noise-induced loss of hearing as compared to the group with normal hearing. "Out of 196 male industrial workers 44 had a severe loss of hearing at either 3000, 4000 or 6000 Hz but not at other frequencies indicating that this impairment was due to noise." No direct proof exists that noise caused the BP rise in the workers, but "the most reasonable explanation to the presented findings is that prolonged exposure to a stressful stimulus may have caused repeated rises in blood-pressure leading to circulatory adaptations and a permanent rise in blood-pressure."

Overall Evaluation:

Study design provides inadequate baseline, exposure and response data to support the major conclusion that hearing loss was associated with noise exposures and permanent rise in blood pressure.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 3
Epidemiologic Method = 4

Citation: Kavoussi, N.: The Relationship Between the Length of Exposure to Noise and the Incidence of Hypertension at a Silo in Tehran. Med. Lavoro 64(7-8):292-295, 1973. (English)

Researchers and Institution where research performed:
Kavoussi - Associate Professor of Occupational Health, School of Public Health, University of Tehran, Iran. MPH Thesis submitted to U.N.C. at Chapel Hill, North Carolina.

Stated Purpose: To investigate the probable relationship between the duration of exposure to a noisy environment and the evidence of high blood pressure among the workers and employees.

Study Design and Sample:
: Occupational group - machinery workers in a wheat silo.
: Cross-sectional data collected in May, 1971.
: Sample of 465 men aged up to 39, 40-54, 55-64 years.
: Sampling methodology not given, 66% of employees studied.
: Men grouped by length of employment, up to 10 years, 11-25 years, and over 25 years of employment.

Data Sources : Information obtained from forms which were first partly filled-in by the subjects and then subsequently completed after the medical examination.
: Prevalence data with all inherent biases.

Bias Potential in Design:
Selective survival, incomplete ascertainment of total group at risk, non-response bias.

Noise Exposure:
Noise Description:
Source : Silo machinery noise, actual machines or devices not identified.
Type : Unsteady machinery noise in a silo.
Frequency Composition: Not measured.
Levels: Not measured (although author said that a judgment about the intensity of the noise is in the fact that workers could not understand each other when speaking.)
Duration of Exposure: Not known accurately - reportedly worked around noise of up to 10 years, up to 25 years, over 25 years.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; silo for storing and moving 64,000 tons of wheat.
Subjects : Only history of exposure in the silo work situation reported, no history of avocational exposure, hearing thresholds, history of ear disease, or otological examination.
Evaluation : Poor regarding noise parameters. Sources of noise not specified. Although noise not measured, it is likely that it was at a hazardous level because the workers "could not understand each other when speaking".

Health Effects:

CVS Response : The average of three blood pressure readings taken in a supine position, five minutes after a one hour seated rest, before work in the morning. Hypertension defined as 140/90 or greater. The Vaquez apparatus was used. No data as to the training of personnel, number of individuals under antihypertensive treatment, etc.

Evaluation : Data inadequate to judge quality of blood pressure measurement. Temporal relationship of exposure to development of health effects poor for judging causality - initial blood pressures not known.

Judging Causal Significance:

Strength of the Association: No effect parameters specified.

Statistical Methods: No statistical tests given. No mean blood pressure readings shown. Data classified as hypertensive versus normal with percentages of abnormal individuals. The 465 subjects were stratified by age in years, and cross-classified by length of employment in categories of up to 10 years, 11-25 years and over 25 years. Analysis would indicate that observed differences in the proportion of individuals hypertensive by length of employment categories (within age strata) are not significant at the .05 level. In fact the 3.7 (% hypertensive in 40-54 year age group and less than 10 years employment) is barely different from 13.9% (% hypertensive in 40-54 year age group with over 25 years employment) at the .05 level of significance.

Control for Potential Confounders:

No control of confounding variables except for stratification into age groups.

Conclusions:

Author : Author states "from the table it can be seen that there is no case of abnormally high blood pressure in the first age category. This means length of exposure to a noisy environment does not induce high blood pressure in men under 40 years of age. After 40 years of age when there is a greater tendency to develop high blood pressure the length of exposure in a noisy environment can be an additional factor in inducing this condition. In the third age category there is a greater incidence of high blood pressure because age and length of exposure are greater than in the previous categories." The author concludes that the results of this study show that while the main factor inducing high blood pressure is the age of the workers, among the other factors, duration in exposure to noise could be another significant one in causing the condition.

Overall Evaluation:

In this study, length of employment is taken to indicate "duration of exposure to noise". The noise variable itself is not measured. The questionable sampling design, lack of a non-exposed control group and the failure to control for potentially confounding variables makes this study weak for assessing the effects of noise on the cardiovascular system. Given the data, the author's conclusions appear unwarranted.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 3
Epidemiologic Method = 2

Citation: Knipschild, Paul: Medical Effects of Aircraft Noise: Community Cardiovascular Survey. International Archives of Occupational and Environmental Health 40:185-190, 1977. (English)

Researchers and Institution where research performed:
Faculty of Medicine, University of Amsterdam,
The Netherlands.

Stated Purpose: To describe the relationship between aircraft noise and the prevalence of cardiovascular disease. Seven hypotheses were specified.

Study Design and Sample:

: Cross-sectional community survey based on "ecological" exposure as opposed to individual exposure to noise. Data from a CVD survey were categorized by villages which were then divided in relation to aircraft noise exposure. Four villages were designated as suffering from much aircraft noise and four with less noise in the past six years, but no study areas with little or no aircraft noise were defined.

: Sample size - 2233 participants in high noise area and 3595 in the lesser noise area.

: All inhabitants aged 35-64 were invited to participate with only 39% in the high noise area and 43% in the lesser noise area responding. Representativeness of sample in relation to general population not described. Investigator should have demonstrated if there were differences in characteristics between responders in high and low noise areas and between responders and non-responders.

Data Sources : Screening survey using standardized methods - the same letters of invitation to participate, staff and equipment. No mention of "blinding" in methodology.

Bias Potential in Design:

: Ecological fallacy.

: Non-respondent bias - only 42% of the adults in the area responded.

: Migration out of the area of individuals experiencing adverse effects which would tend to minimize differences between the groups, except that in high noise areas persons with problems may have responded while in the lesser noise areas the healthier group may have predominated.

Noise Exposure:
Noise Description:
Source : Aircraft flying over living area; noise measured in the center of the village.
Type : Aircraft noise, unsteady.
Frequency Composition: Not reported.
Levels: "Much noise" (M): B = 40-60 where NNI > 37. "Less noise" (L): B = 20-40 where NNI = 20-37.

$B = 20 \log \Sigma(n.10^{L/15}) - 157$ in which Σ = attribution to B of all airplanes in a year; n = night factor (day n = 1, night n = 10); L = maximal dB(A) for each airplane. ($NNI \approx 4/5\, B + 5$)

Duration of Exposure: Not known; M villages "had suffered much aircraft noise" in past six years. L villages "with less aircraft noise" had no time given.

Instrumentation: Not reported.

Measurement Procedure: Not reported but implied to be a standardized procedure using standardized equipment.

Environment : Living areas with aircraft noise; uncontrolled.

Subjects : No individual histories of exposure or ear disease and no hearing threshold measurements.

Evaluation : Actual noise levels over the six year period could only be estimated. Actual exposure of individuals not known. Wide range of noise exposure possible in this situation. Other vocational and avocational exposures not investigated. Noise equipment and measurement procedures not available in this article, therefore, lacking regarding description of noise parameters.

Health Effects:

CVS Response : Hypertension defined as BP systolic > 175 and/or diastolic > 100 mm. Hg.; diagnosis of angina pectoris (standardized W.H.O. questions); pathological heart shape on x-ray; pathological E.C.G.; taking CV drugs and under medical treatment as determined by heart specialist.

Evaluation : No original data or description of methods given. Researcher stated that participants in the high noise area were overweight and smoked more, but apparently these variables were not controlled. Treatment effects not considered.

Judging Causal Significance:

Strength of the Association: Weighted regression line: % hypertension = 0, 34B - 0.57 with an explained variation of 78%. (Each increase of B by 3 units caused a 1% increase of participants with hypertension. A higher regression coefficient was found with women and older people.)

Statistical Methods: One-sided at 5% α using combination of 2 x 2 contingency tables (Cochran-Biometrics 10:417-451, 1954).

Dose-Response Relationship: Detected when data were plotted with B (noise level) measured in the center of each village.

Control for Potential Confounders:

Author states that age and sex were controlled in the analysis. Smoking, overweight and social class differences were observed, but no details of the analysis were given.

Conclusions:

Author : "In areas with much aircraft noise (B > 40) the prevalence of cardiovascular diseases appears to be higher. There is strong suggestive evidence that aircraft noise is a causal factor in cases of cardiovascular disease."

Overall Evaluation:

A prevalence study with low response rate, incomplete control of confounding variables, that may suffer from ecologic fallacy and unusual selection factors. In addition, several of the health effect estimates were dependent upon medical care utilization.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 3
Epidemiologic Method = 4

Citation: Knipschild, Paul: Medical Effects of Aircraft Noise: General Practice Survey. International Archives of Occupational and Environmental Health 40:191-196, 1977. (English)

Researchers and Institution where research performed:
Coronel Laboratory for Occupational and Environmental Health, Faculty of Medicine, University of Amsterdam, The Netherlands.

Stated Purpose: To describe long-term effects of aircraft noise on the contact rate with the general practitioner.

Study Design and Sample:
: Cross-sectional design - all G.P. service contacts with known population at risk (PAR) in one week (not clear as to other possible medical contacts in the area).
: PAR in low noise areas is equal to 17,500.
: PAR in high noise areas is equal to 12,000.
: Contact rate in low noise area ($B < 20$) compared to contact rate in high noise areas ($B > 35$).

Data Sources : Reporting by G.P. Study single "blinded" in that patients did not know about goals of study; internal control of otitis and earwax hypothesis suggested G.P. effects on the result were not probable.

Potential Bias in Design:
: Ecologic fallacy.
: Contact rate may not represent independent events, not stated.
: Contact rates may not represent true cross-sectional data since individuals may seek services outside of the area.
: Self-selection into services probable.
: Practice of visits and consultation may be different in the various noise areas.
: G.P.s in noise area were activists in anti-noise pressure groups.

Noise Exposure:
Noise Description:
Source : Aircraft flying over living areas.
Type : Aircraft noise; unsteady.
Frequency Composition: Not reported.
Levels: Exposed area was divided into three areas to study noise-response relationships: E_1: B = 45-55 and E_2: B = 35-45 which approximates NNI = 33-50 and EC: B = 20-35 which approximates NNI = 20-33. Control area B = < 20 or NNI < 20.
Duration of Exposure: Exposed village since 1968 (study in March, 1974) was lying in the direct line of a runway.
Instrumentation: Not reported.
Measurement Procedure: Not reported. Dutch measure "B" used, type not described, presumed to comply with standardized procedure.

Environment : Uncontrolled; living areas in direct line of airplane runway.

Subjects : No data as to history of vocational or avocational exposure, hearing thresholds, history of ear disease or otological examination. No data on individual subject exposure.

Evaluation : Wide range of noise exposure possible in this situation. Noise equipment and noise procedures not available. Lacking regarding description of noise parameters.

Health Effects:

CVS Response : Diagnoses of cardiovascular disease by General Practitioners; criteria used not described; patients seen by different G.P.s in the different areas. Definition of hypertension not given.

Evaluation : Comparability of data not likely. Unequal age populations. Many confounding variables.

Judging Causal Significance:

Strength of the Association: No differences found.

Statistical Methods: One-sided at 5% significance level using a combination of 2 x 2 contingency tables (Cochran, 1954). Data presented as percentages with level of significance for each subgroup.

Dose-Response Relationship: For 15-64 year olds, the contact rate for CVD was 9% in E_1, 6% in E_2 and 5% in area C.

Control for Potential Confounders:

Age and sex taken into account in the analysis. No other confounders considered. Villages differed in terms of socioeconomic status.

Conclusions:

Author : In studying cardiovascular disease for persons aged 15-64 years it was found that a contact rate in the exposed area was almost twice as high as the contact rate in the non-exposed area. In accordance herewith the taking of antihypertensive agents among the 15-64 year old patients was much higher in the exposed area, especially for the female patients. This last finding may be explained by the fact that the women, being at home and not working in neighboring Amsterdam, were exposed more. It was also shown that in the week of the investigation almost no airplanes had passed over the exposed village because of the direction of the wind. This suggests a long-term effect of aircraft noise causing this higher contact rate. "This general practice survey indicated strongly that aircraft noise increases the contact rate with the G.P. for psychological and some psychosomatic problems."

Overall Evaluation:

Data appear adequate for an ecological study. Although not statistically significant and not controlled for confounders, there appeared to be a gradient of increasing contact rates for CVD from the low to the high noise areas.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 0
Epidemiologic Method = 3

Citation: Knipschild, Paul and Sallé, Herman: Road Traffic Noise and Cardiovascular Disease: A Population Study in the Netherlands. International Archives of Occupational & Environmental Health 44: 55-59, 1979. (English)

Researchers and Institution where research was performed:
Coronel Laboratory for Occupational and Environmental Health, University of Amsterdam, The Netherlands.

Stated Purpose: To answer the question whether people living in a street with much traffic (noise) run an increased risk of contracting cardiovascular diseases. Five hypotheses stated.

Study Design and Sample:

: Cross-sectional, ecologic survey; groups retrospectively determined.

: Sample of housewives aged 40-49 living in the eastern part of The Netherlands. 1342 living in "quiet" areas and 399 living in "noisy" areas.

: Response rate - 86%; 11% did not want to be screened and 3% reported they were already under medical control for cardiovascular disease. Differences in participation in housewives living in noisy streets compared with quiet streets are not known.

Data Sources : Extant Cardiovascular Screening Program - Consultation Bureau Project Heart Diseases.

Bias Potential in Design:

: Ecologic fallacy.

: Self-selection into living in noisy or quiet areas.

Noise Exposure:

Noise Description:

Source : "Automobile noise" from the streets.

Type : Unsteady.

Frequency Composition: Not reported.

Levels: "Noisy" streets: L_{eq} = 65-70 dB(A), thus L_{dn}>62.5(A) which represented more than 100 vehicles per hour; "quiet" streets: L_{eq} = 55-60 dB(A), thus L_{dn}<62.5(A).

Duration of Exposure: Not reported.

Instrumentation: Not reported, no dosimeters used.

Measurement Procedure: Not reported.

Environment : Uncontrolled; not indicative of where subjects were located, i.e., in the house, yard, street, etc.

Subjects : No individual data obtained; no history of avocational, vocational exposures, hearing thresholds, history of ear problems, etc.

Evaluation : Poor design relative to noise parameters. Street noise other than traffic could have contributed to total noise. Actual exposures difficult to determine without dosimeters on subjects.

Health Effects:

CVS Response : Consultation with a cardiologist; hypertension: use of antihypertensive drugs and/or a measured BP systolic ≥ 160 and/or diastolic ≥ 105 mm. Hg., in rest, sitting position; angina pectoris according to W.H.O. questionnaire; ischemia on E.C.G. in rest: possible or probable according to the Minnesota coding system; heart shape pathology: on x-ray, according to the cardiologist.

Evaluation : Specific diagnostic criteria not given, reliability unknown, no documentation of types of pre-existing CV disease.

Judging Causal Significance:

Strength of the Association: Not given; unable to determine temporal relationship.

Statistical Methods: Fisher's test, one-sided at $\alpha = .05$.

Control for Potential Confounders:

States that "attention was paid to possibly confounding factors (age, civil status, financial situation, smoking habits, weight, physical activity)." Groups compared on these variables and housewives living in noisy streets were found to be more well-to-do than those in quiet streets. No statistical controlling apparent in the analysis.

Conclusions:

Authors : "The study gives no indication for a relationship between traffic noise and cardiovascular disease." The authors suggest that negative findings may be related to the problem of non-response and confounding factors, the need for samples of great size to detect small differences; the lack of a large difference in noise exposure between the two groups; the fact that noise could not be estimated using noise dosimeters.

Overall Evaluation:

The "ecological" nature of the data limits inferences that may be drawn from these findings, albeit no association was observed.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 2
Epidemiologic Method = 7

Citation: Lees, R.E.M. and Roberts, H.J.: Noise-Induced Hearing Loss and Blood Pressure. CMA Journal 120:1082-1084, 1979. (English)

Researchers and Institution where research performed:
Lees and Roberts - Occupational Health and Safety, Resource Centre, Queens University, Kingston, Ontario.

Stated Purpose: To look for evidence of a relation between hypertension and noise-induced hearing loss in the work force of a local industrial plant.

Study Design and Sample:

: Industrial workers.

: Cross-sectional with hearing loss group chosen as cases, postulating that hypertension is a link in the causal chain to hearing loss.

: Using health records, persons with hearing loss who worked in high noise areas of the plant were selected for study and stratified into age groups (<30, 31-40, 41-50 and 50+ years). From these strata a random sample of 62 subjects were drawn and matched for age and duration of employment with a control group of 62 persons drawn at random from workers employed in quiet areas. Noise-induced hearing loss was defined as attenuation of hearing greatest at 4000Hz and at least 20dB greater than the attenuation at any frequency less than 3000Hz.

: Size of questionable adequacy to represent the population of both the study and comparison group.

Data Source: Company records and primary data collection.

Bias Potential in Design:
Cases of hearing loss may not adequately reflect noise exposure. Difficult to determine selection bias with stratification by age, drawing of a random sample and matching within a relatively small plant. Duration of employment and duration of noise exposure not necessarily equivalent. Baseline blood pressures and hearing levels were not available.

Noise Exposure:
Noise Description:
Source : Industrial noise.
Type : Steady state, no impact.
Frequency Composition: Not specified.
Levels: Noise of between 95 and 98 dBA measured in work areas classed as noisy; areas with ambient noise level of less than 85 dBA according to records of safety engineer were classified as quiet.
Duration of Exposure: Not specified.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled work area.
Subjects : No data as to history of vocational or avocational exposure other than actual hearing loss (greater than 30 dB at 4000Hz), ear disease, hearing conservation program, etc. Audiograms were made after removal from work environment a minimum of 12 hours and no exposure to loud noise in

leisure or recreation during that time.

Evaluation : Poor regarding identifying, measuring and describing noise parameters.

Health Effects:

CVS Response : BP measured by one person using mercury manometer and standard cuff after seven minute resting period and without knowledge of the study group to which subject had been assigned. Hypertension defined as 140/90 or higher.

Evaluation : Race and sex distribution of subjects not given. Time (in relation to work day and noise exposure) of BP recording and definition of diastolic BP measurement not specified. No data regarding comorbidity, pre-employment BP, medications taken, etc. were provided.

Judging Causal Significance:

Strength of the Association: None observed.

Statistical Methods: Not stated; means and standard deviations calculated for each age group; "No difference between the two groups in number of persons with hypertension, nor was there a significant difference between the groups in the mean SBP or DBP or either of the standard deviations."

Control for Potential Confounders:

Age and duration of employment matched in the hearing loss and control groups. No other confounders considered.

Conclusions:

Authors : "We could find no evidence of a relation between increased systolic or diastolic blood pressure and hearing loss...If a relation between BP and noise-induced hearing loss does exist at high levels of hearing loss, it may be that elevation of BP is secondary to the stress of a long period in a noisy work environment. The results of this study suggest that the reverse is not the case."

Overall Evaluation:

Study is weak in evidence to assess noise exposure since hearing loss is used as surrogate. However, as a surrogate study, subjects with "noise-induced" hearing loss were identified from among workers exposed in high noise areas. It is not clear why such a small random sample of eligible subjects was drawn. Mean BP does not rise with age, S.D. does but samples are small within age strata. Small sample size and the negative results suggest concerns for Type II error. An additional control group of persons with no demonstrated hearing loss but exposure to a noisy work environment could have improved the design.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effect = 8
Epidemiologic Method = 8

Citation: Lees, R.E.M., Smith, C.S. and Wetherall, L.D.: A Study of Stress Indicators in Workers Exposed to Industrial Noise. Canadian Journal of Public Health 71(4):261-265, 1980. (English)

Researchers and Institution where research performed:
Occupational Health and Safety Resource Centre, Queens University, Kingston, Ontario.

Stated Purpose: Not explicitly stated; implied that investigation was to examine the long-term morbidity of people exposed to prolonged noise.

Study Design and Sample:

- Occupational groups working in production and material handling areas.
- Historical prospective study, paired-cohort of two groups of workers, January, 1962-December, 1976.
- Two groups were selected from 1093 workers in production and material handling as of January 1, 1962. Size was limited by the number of employees who had worked exclusively in a low noise area for the entire fifteen year period (88). From the possible 88 in the low exposure group, 70 were matched by age (within five years), exposure period and duration of employment to the high exposure group (leaving 36 persons who could not be matched.) Workers exposed at 85-90 dBA (intermediate noise level) and those under age 40 years, so that none would retire during the study period, were excluded in addition to clerical and management personnel.
- Sample size was small and incidence of disease was low. (Authors indicate that this was a major problem.)

Data Sources : Comprehensive medical records were made available to researchers.

Bias Potential in Design:
Establishment of the cohort is unclear; uncertain as to whether any workers in unusual exposures were excluded; no attrition noted in fifteen years, suggesting an unusual cohort.

Noise Exposure:
Noise Description:
Source : "Industrial;" sources of noise not reported.
Type : Not reported as to steady or unsteady.
Frequency Composition: Not reported.
Levels: "High level" - occupationally exposed to prolonged high level noise greater than 90 dBA for a minimum of three consecutive years (when high exposures were interspersed with low, the longest period of high noise was considered the exposure period). "Low level" - less than 85 dBA ambient noise for total work history in plant.
Duration of Exposure: Based on eight hour work shifts; 30 pairs exposed

for 3-6 years; 22 pairs exposed 7-10 years and 18 pairs exposed 11-15 years.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled.

Subjects : Used company records to determine history of vocational exposure, but no details as to how noise exposure was measured other than being assigned to a given area of the plant. No data on history of avocational noise exposure, hearing thresholds, history of ear disease or otological examination, although comprehensive medical records were available.

Evaluation : Poor regarding identifying, measuring and describing noise parameters. Use of number of years in the work area is too general a measure of noise exposure. For both high and low level noise groups, subject variance in shifts caused difficulty in pairing on durations of exposure, e.g. 23 low noise and 56 high noise subjects were on rotating shifts while 47 high and 14 low noise subjects were on other shifts.

Health Effects:

CVS Response : Counts of number of new events for IHD, hypertension, myocardial infarction as well as peptic ulcer, diabetes and mental illness, headache, absenteeism and accidents. January, 1962 served as baseline of morbidity measurements.

Evaluation : Health status as of January, 1962, not given; no co-morbidities, treatments, medications given. No diagnostic criteria specified, therefore difficult to assess.

Judging Causal Significance:

Strength of the Association: "In order to ses any meaningful results the increased risk of contracting the disease in the exposed group would have had to have been in the order of 300 to 1000%. This was not the case. The risk ratio for any of the disease categories at its highest was approximately two. With this level of risk and with very high disease incidence rate (1 in 100) it would have required a sample many times larger than the one available to use in order to establish any meaningful results."

Statistical Methods: Univariate methods of analysis employed, Pearson's correlation, cross-tabulations and one-way analysis of variance yielded insignificant x^2 and F values. Matching apparently not taken into account in analysis. No data for dose-response relationship available since intermediate noise level excluded.

Control for Potential Confounders:

Groups matched to take into account age, exposure period and duration of employment. Work shift controlled in analysis. (Correlation between noise exposure and shift $r = 0.48$, $p = .001$.)

Conclusions:

Authors : "The baseline medical data showed no significant difference between the cohorts on the starting date in 1962." There were no significant differences between the two groups for both the exposure periods and total period of the study in incidence of first, second and third new medical conditions. Also there was no significant difference between the onset of new medical conditions and years of exposure nor age. "Medical conditions were ascertained by type. Due to the small sample size, the increased risk would have to be on the order of 3 to 10 times to enable us to reject the null hypothesis. This was not the case."

Overall Evaluation:

The major strength of this study is its historical prospective approach. Unfortunately, as indicated by the authors, the sample size was prohibitively small. Nevertheless, the validity of the inferences from this study showing negative results may have been improved by a matched pair analysis of the data in keeping with the matched design and by taking into account work-shift as a confounding variable. The use of different exposure periods within the "cohorts" introduces another time variable which would confuse dose-response relationships if various noise levels were identifiable.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 3
Epidemiologic Method = 5

Citation: Malchaire, J.B. and Mullier, M.: Occupational Exposure to Noise and Hypertension: A Retrospective Study. Annals of Occupational Hygiene 22:63-66, 1979. (English)

Researchers and Institution where research performed:
Malchaire and Mullier - Industrial Hygiene Research Unit, University of Louvain, Brussels, Belgium.

Stated Purpose: Verifying in two different industries the possible existence of a link between noise exposure and hearing loss and high BP.

Study Design and Sample:

: Occupational groups - car assembly line and wire mill workers.

: Authors describe study as retrospective, but design appears to be that of a cross-sectional study using two high noise groups and a control group of working individuals not exposed to noise. Subjects were further divided into hearing loss and no hearing loss groups.

: Sample of males who appear to come from same social stratum. 1030 car assembly line workers and 581 wire mill workers on whom data had been collected in the previous 3-4 years; excluded those with known histories of CVD, hearing impairments "possibly due to causes other than noise," and labile BP. 510 controls from same companies "never exposed to noise during working life." Completeness of sample unknown.

Data Sources : Company records; collected over a 3-4 year period prior to initiation of study.

Bias Potential in Design:
Cohort not identified by year of employment, etc., so difficult to determine possible bias from exclusions. Appears to be data similar to "screening" programs in industry. Data collected over 3-4 year period with potential measurement bias, survival, diagnostic bias; measurement not "blinded"; those persons with known high BP may have avoided the program.

Noise Exposure:
Noise Description:
Source : Car assembly line and wire mill "noise" with no identification of specific noise sources.
Type : Fluctuating; car assembly line and wire mill noise.
Frequency Composition: Not specified.
Levels: 92 to 100 dB(A) in car assembly plant; 93 to 97 dB(A) in wire mill. In both cases the average equivalent noise level = 95 ± dB(A).
Duration of Exposure: Not specified.
Instrumentation: Dosimeters, no details given.
Measurement Procedure: Taken repeatedly; no indication of compliance with standards.
Environment : Uncontrolled.

Subjects : No data as to history of vocational or avocational noise exposure, but at least "3-4 years" employment on job when previous data were collected. Hearing thresholds: audiometric tests performed over 3-4 year period; authors report no details except hearing deficit groups had average of hearing levels at 1, 2 and 3 kHz for both ears "less or greater" (which is confusing) than 25 dB. It is presumed that authors meant greater than 25 dB unless a precipitous loss applies. Otological examination implied only, history of ear disease not specified.

Evaluation : Lacking in description of noise parameters, instrumentation, measurement procedure, history and duration of noise exposure, hearing conservation measures, etc.

Health Effects:

CVS Response : BP taken manually by occupational physicians, according to the same technique. Individuals with CVD excluded.

Evaluation : Criteria for determining diastolic reading not stated; failed to specify which BP was recorded (readings taken over 3-4 year period; unknown number of readings taken in one assessment period); failed to indicate whether BP was measured pre or post work shift; no mention of pre-employment BP, antihypertensive medications. W.H.O. criteria for hypertension used.

Judging Causal Significance:

Strength of the Association: No association observed between noise exposure and BP except "for the 30-39 age group and for the pooled group of people with a hearing deficit greater than 25 dB."

Statistical Methods: 27 Chi-square tests were performed with one statistically significant at the confidence level 2.5%.

Temporal Relationship: Unable to determine.

Control for Potential Confounders:

Control of age and hearing deficit through stratification except that control group apparently lacked data on hearing. All males of similar social class. Potential confounders not considered were: noise exposure other than work, previous exposure, BP medications, physical activity, obesity, comorbidities.

Conclusions:

Authors : "...it does not indicate any relationship between exposure to noise as depicted by hearing deficit and blood pressure level....Our study shows that the prevalence of hypertension does not appear to be greater among workers exposed to equivalent noise levels of around 95 dB(A) than in the general male working population....exposure to equivalent noise levels around 95 dB(A) cannot be held responsible for causing hypertension."

Overall Evaluation:

The possibility of Type II error exists and the study design used is weak in addressing this type error. Reanalysis of the data combining noise exposed subjects in both plants and defining hypertension as BP > 140/90 (hypertensives plus borderline subjects) suggests that within each age group, the percentage of hypertensives increases from "the not noise exposed group" to "the noise-exposed but no hearing loss group" to "the noise exposed plus hearing loss group." Evidence is very weak for concluding that noise around 95 dB cannot "cause" hypertension.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 5
Epidemiologic Method = 7

Citation: Manninen, O. and Aro, S.: Noise-Induced Hearing Loss and Blood Pressure. International Archives of Occupational and Environmental Health 42:251-256, 1979. (English)

Researchers and Institution where research performed:
Department of Public Health, Faculty of Medicine, University of Tampere, Tampere, Finland.

Stated Purpose: To investigate the association between exposure to long-term occupational noise and SBP and DBP among workers in the Finnish engineering industry.

Study Design and Sample:

: Occupational groups from engineering factories.
: Hearing loss levels used as surrogates for noise exposure levels.
: Cross-sectional data from a systematic stratified sample; no details given.
: Final sample size of 280 persons (188 male and 92 female).
: Subjects classified into three hearing classes: mild, moderate and severe losses and compared on BP.
: Sample size too small to make comparisons among females in the three hearing classes.

Data Sources : Collected as a part of the METELI Collaborative Project 1971-1976 financed by the Social Science Research Council of the Academy of Finland and by the Ministry of Education.

Bias Potential in Design:

Cross-sectional data which may suffer from problems of selective survival and selection into and attrition from the various work areas of the engineering industry. The severest hearing loss associated with lower BP in the older group suggests selection problems in light of knowledge of pathophysiology. Variables on which sample stratified were not reported. Misclassification may result from employing hearing loss as a surrogate measure of noise exposure.

Noise Exposure:
Noise Description:
Source : Generalized description of production lines "varied greatly with a range of products from huge paper machines and marine diesel engines through tractors, outboard motors to shotguns to delicate electric meters."
Type : Production line noise; steady or unsteady not reported.
Frequency Composition: Not reported.
Levels : Distributions of noise levels described in detail elsewhere in article.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Not described.
Subjects : History of vocational and avocational noise exposure not reported; history of ear disease excluded individuals from

study. Hearing thresholds for both ears were obtained after noise exposure; tested at frequencies of 125-8000 Hz with air conducted pure tones using a clinical Maico-audiometer. Using the frequencies 3000, 4000 and 6000 Hz, subjects were classified as having mild hearing loss (Class I, loss of hearing no more than 40 dB at any of the three frequencies); moderate loss (Class II, loss of hearing 45-60 dB) and severe hearing loss (Class III, loss of hearing 60 dB or more).

Evaluation : Poor study relative to reporting of noise parameters, and audiometric tests used as a basis for appraisal of long-term exposure.

Health Effects:

CVS Response : Casual BP reading, recorded from right upper extremity in a sitting position, subject at rest for a few minutes. SBP recorded using Hg. sphygmomanometer at 2nd sound and DBP at point of disappearance of sounds (V) with values read to an accuracy of 2 mm. Hg.

Evaluation : Duration of rest and number of readings taken were not described. All readings taken by a nurse who apparently was "blind" to the hearing problem. Duration of employment and exposure were not stated. There were no controls for confounding variables other than sex specific analysis and exclusive of individuals taking BP medications and relative weight. In light of knowledge of pathophysiology, it is difficult to understand the observed severe hearing loss associated with less BP change. BP measurement variation was within expected range except for Hearing Class I, DBP in males.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively. Findings reported to be somewhat consistent with those of Jonsson and Hansson although the differences observed in previous studies were larger than in this study.

Statistical Methods: Student's t-test to indicate differences in mean BP's between the groups. Data need to be reexamined with variables used in a continuous fashion.

Temporal Relationship: Unable to determine with prevalence data.

Control for Potential Confounders:

: Excluded subjects who used antihypertensive drugs or had chronic urinary infection or had hearing impairment not attributable to noise damage. The mean relative weight of subjects in the same age/sex group were practically identical and therefore not considered. The data were stratified into two wide age groupings (26-40 years and 41-64 years) rather than using age as a continuous variable.

: No evidence of controlling for socio-economic level, length of employment or other environmental variables.

Conclusions:

Authors : "Results...indicate that there is a relationship between BP and noise-induced hearing disorder. Prolonged exposure to industrial types of noise first elevates the SBP and to some extent the DBP as well. If the noise exposure continues, with the resulting severe hearing loss, the SBP tends to return to normal. DBP seems to either rise or fall. Obviously, prospective studies are needed to verify these conclusions."

Overall Evaluation:

The cross-sectional design provides inadequate baseline and change data to support the above conclusions, although the study presents some evidence of a positive relationship between noise and BP especially among older males (41-65 years of age). Data reclassified in a retrospective cohort manner, since noise exposure data reportedly is available elsewhere, would greatly enhance this design and perhaps offer more convincing evidence of a causal association. It is questionable as to whether a true control group of "normal" hearing was employed - appears to use internal controls only. Little control of confounders, and when data were available such as with age and relative weight, they were not utilized to the maximum as continuous variables in the analysis.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 4
Epidemiologic Method = 5

Citation: Meecham, W.C. and Shaw, Neil: Effects of Jet Noise on Mortality Rates. British Journal of Audiology 13(3):77-80, 1979. (English)

Researchers and Institution where research performed:
University of California, Los Angeles.

Stated Purpose: Not specifically stated. ". . .a study of mortality rates . . .on residents living close to a large jet airport."

Study Design and Sample:
: Cross-sectional, ecologic study using mortality data.
: 86,200 population of the test area - area of high noise radiation within the 90 dBA noise contour; 77,968 population of the control area with background noise level of 45-50 dBA.

Data Sources:
Mortality : Actual death occurrences for the test and control areas for 1970-71 obtained from computer tapes of Los Angeles County Department of Health Services.
Population : U.S. Census Tapes, Fourth Count.

Bias Potential in Design:
: Design suffers from all of the potential bias inherent in mortality studies such as inaccuracy in statement of cause of death, diagnostic differences, methods of certification, differences in the medical services in the test and control areas; the reported fact that in both areas only about 65% of the expected deaths were reported in the very poor areas (reporting errors different in the two areas). The data are ecological in that it is assumed that those dying in the test area were exposed to noise and those dying in the control area were not so exposed to noise.

Noise Exposure:
Noise Description:
Source : Jet engines in aircraft.
Type : Jet engines (unsteady).
Frequency Composition: Not specified.
Levels: Test area: within the 90 dBA noise contour (90 dBA or more); Control area: 45-50 dBA. No documentation as to whether levels were tested in yards, within homes, on streets, etc.
Duration of Exposure: Not reported.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Uncontrolled; neighborhood flown over by jet aircraft.
Subjects : No individual data reported; life styles, history of exposure, otological problems, hearing thresholds, etc. not known.
Evaluation : Improper to draw conclusions based upon unknown noise levels. One would need to know the total exposure of each subject, including time shielded by enclosures such as a house or car.

Health Effects:

CVS Response : No specific morbidity measures. Authors considered deaths from stroke and cirrhosis of the liver as relevant health measures.

Evaluation : Validity of cause of death criteria not stated (death certificates, autopsies, percentage of autopsies in the 2 groups, number of deaths in hospitals). There were significant differences in the populations, especially Asiatic (2.7% test group and 18.1% control) which may affect incidence of deaths especially in high blood pressure related diseases.

Judging Causal Significance:

Strength of the Association: Not reported; unable to determine with ecological data.

Temporal Relationship: Unable to determine with cross-sectional data.

Statistical Methods: Chi-square statistics used to test differences between test and control areas with expected deaths calculated on conservative assumption of a 20% increase in the test area.

: Statistics employed to conclude "the increase in death due to stroke is not quite statistically significant," is not given.

Control for Potential Confounders:

: "The two areas were matched as closely as possible in age, income and racial breakdown," but no statistical controls were employed when age and race distributions in the groups were found to differ.

: There was no controlling for other potential risk factors.

Conclusions:

Authors : "The major result is that for these two diseases (stroke and cirrhosis of the liver), often associated with increased daily nervous tension, there has been an increase in mortality rates for the area of heavy noise radiation under landing jet aircraft as compared with an area removed from such noise effects.

To sum up, there appears to be a significant increase in deaths which we attribute to the constant nerve shattering noise experienced by people living underneath landing jet aircraft. Further studies certainly are needed."

Overall Evaluation:

Lacks information on noise parameters, poor controlling for confounding, use of mortality data and ecological nature of data limits usefulness of this study in judging effects of noise on the cardiovascular system. The major problem in the analysis of these mortality data is the lack of controlling for age and race differences.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method= 1

Citation: II. Mosskov , J.I. and Ettema, J.H.: Extra-Auditory Effects in Short-Term Exposure to Aircraft and Traffic Noise. International Archives of Occupational and Environmental Health 40:165-173, 1977. (English)

III. Mosskov, J.I. and Ettema, J.H.: Extra-Auditory Effects in Short-Term Exposure to Noise from a Textile Factory. International Archives of Occupational and Environmental Health 40: 174-176, 1977. (English)

IV. Mosskov, J.I. and Ettema, J.H.: Extra-Auditory Effects in Long-Term Exposure to Aircraft and Traffic Noise. International Archives of Occupational and Environmental Health 40:177-184, 1977. (English)

Researchers and Institution where research was performed:
Coronel Laboratory for Occupational and Environmental Health, Faculty of Medicine, University of Amsterdam, The Netherlands.

Stated Purpose: A series of three experiments to:
II. Study the effect of combined workload (aircraft and traffic noise and mental load) on circulatory and respiratory parameters;
III. Determine if effects similar to those observed in II are induced by exposure to factory noise;
IV. Study changes in the cardio-respiratory parameters in relation to duration of exposure (up to three hours).

Study Design and Sample:
: Experiments using 12 healthy male subjects aged 19-26 as their own controls.
: Design consisted of an adaptation period, rest period, exposure period and rest period. Subjects performed sessions in random sequence with random sequence of experimental load.
: Determination of sample size not given.

Data Sources : Controlled laboratory experiment.

Bias Potential in Design:
Some measure of lability of BP might be considered to take out the "reactors." While in studies with large samples, "reactors" might be randomly assorted, there is less assurance of this when dealing with small samples. Experiments may not adequately simulate real life situations.

Noise Exposure:
Noise Description - Ref. II:
Source : Taped noise presented through headphones in "soundproof" room.
Type : Aircraft noise (take off and landing of seven planes); traffic noise.
Frequency Composition: Not specified.

Levels: Aircraft: L_{eq} 84-91 dB(A); traffic: L_{eq} 83.5 dB(A); total duration of noise 30-40 seconds; highest intensity for 6-10 seconds and free intervals for 40-180 seconds.
Duration of Exposure: Three 15 minute periods of exposure with two rest periods of 5 minutes inbetween.

Noise Description - Ref. III:
Source : Tape recording of noise presented through a loudspeaker in a "soundproof" room.
Type : Textile factory noise.
Frequency Composition: Not specified.
Levels: L_{eq} 98 dB(A).
Duration of Exposure: Same as II above.

Noise Description - Ref. IV:
Source : Taped noise presented through loudspeakers in a "soundproof" room.
Type : Aircraft, twenty flyovers per hour; and traffic.
Frequency Composition: Not specified.
Levels: Aircraft 89-100 dB(A), varied; peak value, periods of 20-30 seconds; traffic L_{eq}: 73.2 dB(A).
Duration of exposure: 180 minutes.

Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Controlled.
Subjects : All reported as healthy with negative otoscopic, audiometric, neurological, cardiorespiratory findings. History of vocational and avocational exposure not given.
Evaluation : Poor, regarding noise factors.

Health Effects:
CVS Response : BP by cuff method; heart rate by cardiotachometer; pulse pressure; sinusarrhymia, hand-scored; respiratory rate by thermistor at nasal opening.
Evaluation : Data as to when and how BP was taken was not recorded; average or single readings per subject not noted; not known if examiners were blind to study hypotheses; not noted as to when respirations and heart rate were recorded - if readings were not time constant on cardiotachometer and respiratory thermistor, the heart rate response could be affected when recorded by the minute.
: Changes of decreased heart rate, increased DBP and decreased SBP do not make sense. Change in sinusarrhymias indicate a decrease in parasympathetic tone, but opposite effect observed on heart rate.
: One wonders about digit discrimination in BP recording.

Judging Causal Significance:
Strength of the Association: Not stated.
Statistical Methods: Wilcoxon test.

Control for Potential Confounders:
Random assignment of noise type.

Conclusions:

Authors : Ref. II: "In this experiment aircraft noise had a slight decreasing effect on heart rate and systolic pressure.... In all conditions an increase of diastolic pressure and decrease of pulse pressure, sinusarrhythmia and HR/RR was found....in the condition combined load diastolic pressure was increased also in the periods without noise. Mental load and combined load caused an increase of respiratory rate, whereas exposure to noise alone did not result in a (significant) increase."

"Our study...strongly indicate(s) that under conditions of daily work and living, noise exposure may impair information processing and so decrease productivity and increase the risk of accidents."

Ref. III: Textile industry noise - "Increase of diastolic blood pressure and of respiratory rate and decrease pulse pressure and heart rate were observed." "The effects are qualitatively similar to those induced by exposure to aircraft and traffic noise, and to those induced by performance of a mental task."

Ref. IV: "Aircraft noise (L_{eq} = 78 dB(A)) causes decrease of heart rate, increase of diastolic blood pressure, decrease of pulse pressure.

-Traffic noise (L_{eq} = 73 dB(A)) causes decrease of systolic blood pressure, increase of diastolic blood pressure, decrease of pulse pressure, increase of respiratory rate, decrease of quotient of heart rate/respiratory rate."

"-There is an increase of systolic and diastolic blood pressure, an suppression of sinus arrhythmia, and increase of respiratory rate and a decrease of HR/RR, when exposure to noise is combined with a mental task."

"Exposure to both aircraft and traffic noise caused an increase of diastolic blood pressure. Such a finding appears to be important: it at least suggests a causal relationship between exposure to noise and hypertension."

Overall Evaluation:

Although this was a simulation study of aircraft, traffic and textile factory noise in a controlled experiment, the lack of precision as to the noise and health parameters appears to invalidate the authors' conclusions of a causal relationship between noise and cardiovascular disease. One would question whether the random assignment of noise type to so few subjects would adequately control for confounding factors. There were differences in SBP, DBP, pulse pressure and sinusarrhythmias between the "rest" periods. This alone may mitigate some of the differences with exposure. It is not clear how and why a Wilcoxon test, usually best when measurement is in an ordinal scale both within and between pairs, was applied to the data.

(Scores on a scale of 0-9)

II Noise Exposure = 4
Health Effects = 3
Epidemiologic Method = 3

III Noise Exposure = 3
Health Effects = 3
Epidemiologic Method = 3

IV Noise Exposure = 4
Health Effects = 3
Epidemiologic Method = 7

Citation: Ohrstrom, E. and Bjorkman, M.: Medical Symptoms in Noisy Industries. Journal of Sound and Vibration 59(1):115-118, 1978. (English)

Researchers and Institution where research performed:
Department of Environmental Hygiene, Gothenburg University, Gothenburg, Sweden.

Stated Purpose: A general examination of the pleasantness and comfort of the working environment.

Study Design and Sample:

: Occupational groups from the machine and textile industries.
: Cross-sectional data.
: 75 workers in the machine industry and 99 in the textile industry who worked eight hours a day in noisy areas and 49 workers exposed for only a four hour day in the noisy areas.
: Sample size questionable as indicated by author - "This material is based upon two different populations and is rather limited in terms of number of individuals - that is, male machine workers of rather high average age and length of employment who work independently and whose work is also demanding; and female workers of a rather low average age and short length of employment who have monotonous, undemanding jobs which require no special education."

Data Sources : Primary data from interviews and noise measurements.

Bias Potential in Design:
No data given on participation rate. Groups pooled for analysis not comparable in major variables such as sex and age.

Noise Exposure:
Noise Description:
Source : Textile mill machines and machine shop ("striking" to "impulse" noises.)
Type : Machine shop: noise varied as much as 40 dB(A); textile mill: noise varied no more than 10 dB(A).
Frequency Composition: Not reported although article states "the noise frequency distribution was also analyzed."
Levels: Machine shop L_{eq}: 70-80 dB(A) with peak to background 40 dB(A).
Textile mills: L_{eq}: 3 groups:
70-80 dB(A) with peak to background 10 dB(A);
80-90 dB(A) with peak to background 5 dB(A);
90-100 dB(A) with peak to background 5 dB(A).
Duration of Exposure: Not clear, based on eight hour and four hour work day.
Instrumentation: Not recorded.
Measurement Procedure: Not recorded; not clear where machines were located relative to worker; not reported where SLM was located while measurements were taken or when measurements were made.

Subjects : No data as to history of vocational or avocational exposure, hearing thresholds, history of ear exams.

Evaluation : Poor study regarding quantifying noise and exposure to it.

Health Effects:

CVS Response : No specific effects or symptoms related to the cardiovascular system reported. Implied that fatigue may be related to heart rate and blood pressure. Health variables studied were fatigue and other symptoms such as headache, vertigo, nausea, annoyance. Questionnaire and method used in obtaining data not given. Prevalence of symptoms in the general population not known.

Evaluation : Data very subjective with no specific symptoms related to the CVS reported. Race and sex distribution of subjects not given.

Judging Causal Significance:

Strength of the Association: Not reported.

Statistical Methods: Correlation coefficients calculated (r_{xy}) from categorical data.

Control for Potential Confounders:

No potential confounders such as age, sex, duration of exposure, dust, ventilation, considered although data were collected.

Conclusions:

Authors : "Fatigue increases with a higher noise level and a longer period of exposure." (Correlation 0.96.) "Headaches are somewhat less related to noise level than is fatigue."

Overall Evaluation:

Study not very useful in assessing effects of noise on the cardiovascular system.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effect = 2
Epidemiologic Method = 2

Citation: Parvizpoor, Daryoush. Noise Exposure and Prevalence of High Blood Pressure Among Weavers in Iran. Journal of Occupational Medicine 18:730-731, 1976. (English)

Researchers and Institution where research performed:
Parvizpoor - Department of Occupational Health, University of Tehran, School of Public Health, Tehran, Iran.

Stated Purpose: To investigate the effect of long-term occupational exposure to noise on BP in a generally stable population.

Study Design and Sample:
: Occupational groups - weavers in textile industry versus control subjects from light industry.
: Cross-sectional data.
: Sample of 821 male weavers from three textile mills randomly chosen from 20 mills with 200+ workers. 412 randomly selected controls of similar socio-economic conditions working in light industries without occupational noise exposure.
: Size - adequacy questionable. Basis for 412 controls or 50% fewer controls than exposed not given.

Data Sources : Primary data collection.

Bias Potential in Design:
Difficult to determine extent to which healthy worker effect equally likely in weavers and controls. Data ecological in the sense that average noise exposure for the three mills rather than individual exposures to noise were used in classifying exposed individuals.

Noise Exposure:
Noise Description:
Source : Not specified; "in textile mill workrooms."
Type : Not specified as to steady or unsteady.
Frequency Composition: Not specified.
Levels: 96 dBA without significant variations. No documentation of noise level among control environments.
Duration of Exposure: Not specified.
Instrumentation: Not specified.
Measurement Procedure: Not specified.
Environment : Not specified; insufficient data regarding textile mills and workers' locations relative to noise sources.
Subjects : No data as to history of vocational or avocational noise exposure, hearing thresholds, ear disease; hearing conservation program participation, etc.
Evaluation : Poor study in regard to classification of noise parameters.

Health Effects:
CVS Response : BP measured in right arm and in sitting position after 5-10 minutes rest; quiet room; prior to work.
Evalutaion : Documentation of family history of cardiovascular disease among weavers, but not among controls. No data given as to

health of subjects except that seven with family history of hypertension and CVD were excluded. Pre-employment BP, duration of elevated BP, medications taken were not discussed. Standard W.H.O. criteria of hypertension used (normotensive BP = 140/90; hypertensive BP > 160/95; borderline = BP inbetween above figures); BP readings apparently not standardized and not masked. It is unclear as to whether a single or multiple readings were taken.

Judging Causal Significance:

Strength of the Association: Not given but a crude odds (prevalence) ratio of 4.13 would indicate a strong relationship. Findings consistent with other studies cited.

Statistical Methods: Tests employed not given. "Hypertensive rates (among) weavers) differed significantly from those of the control group ($p < 0.01$)."

Dose-Response Relationship: If length of employment is taken as an indicator of noise exposure duration, there was an increase in prevalence of hypertension with increase in length of employment.

Temporal relationship: Unable to determine with prevalence data.

Control for Potential Confounders:

Excluded seven weavers with family history of CVD but no mention of examination of controls. Length of employment and sex of controls not given. Control group similar to weavers in socio-economic status; stratified by age. No evidence of controlling for antihypertensive medications, noise exposure other than work, previous exposure, or other potential confounders.

Conclusions:

Author : "The findings among those men employed at the textile mills show that they have a significantly greater risk of developing hypertension and that this difference appears already at relatively young ages (30-39) and increases with length of employment. In many industrial activities workers are exposed to much higher noise levels than the 96 dBA observed at the textile mills studies. The findings reported suggest that occupational exposure to noise that slightly exceeds the permissible levels of 85-90 dBA does produce nonauditory effects."

Overall Evaluation:

Although the study utilized prevalence data, it presents some evidence in favor of a noise-BP relationship after age is controlled. Study design provides inadequate baseline and noise exposure data to support the major conclusion that noise above 85-90 dBA produces nonauditory effects.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 8
Epidemiologic Method = 6

Citation: Proniewska, W., Kalicinski, I., Kinalska, I., Kordecki, R., Pawlicka, E., and Swianiewicz, W.: Effect of Noise on the Lipid Components of Blood. Acta Physiologica Polonica XXIII (4):705-710, 1972. (English)

Researchers and Institution where research performed:

: D.A. Kalicinski - Cardiological Clinic, Institute of Internal Diseases, Medical Academy, Bialystok.

: Dr. R. Kordecki - Department of Physiology, Medical Academy, Bialystok.

Stated Purpose: To assess the changes in free fatty acid (FFA) level in blood of spinners and weavers at subsequent time intervals during an 8 hour shift.

Study Design and Sample:

: Occupational groups - spinners and weavers.

: Cross-sectional data.

: Sample of 121 females, aged 20-40 years working in noise of 110 dB and divided into groups for blood sampling as follows:

I = 20 persons, tested before work
II = 10 persons, tested between 30-50 minutes of work
III = 24 persons, tested between 60-90 minutes of work
IV = 18 persons, tested between 2-3 hours of work
V = 10 persons, tested between 3-4 hours of work
VI = 12 persons, tested between 5-6 hours of work
VII = 16 persons, tested between 7-8 hours of work

Nine females performing similar work in a room of so-called relative silence. These controls were tested before work and in the 7th hour of work.

Data Sources: Primary data collection.

Bias Potential in Design:

Control and test subject data not comparable. Study group did not have serial blood tests on the same persons as did the controls, resulting in inadequate controlling for intraindividual differences and changes.

Noise Exposure:

Noise Description:

Source : Spinning and weaving machine noises of a textile factory.

Type : Not reported as to steady or unsteady. Presume noise from spinning and weaving machines is steady.

Frequency Composition: 31.5 to 16,000 Hz

Levels: 110 dB

Duration of Exposure: Subjects had worked 1-10 years in factory room.

Instrumentation: Type not reported: B and K type 2203 apparatus which complies with ANSI or ISO standards.

Measurement Procedure: Not reported, but "taken by a team" from the Institute of Occupational Health in Textile and Chemical Industries, Lodz.

Environment : Uncontrolled factory room, temperature 24°C, relative humidity 78%. Relative locations of subjects and noise sources in the room are not described.

Subjects : No exploration of other work exposure to noise or avocational exposures. Hearing thresholds, history of ear disease and otological examinations were not reported.

Evaluation : The specific noise sources were not identified and noise measurement procedure was not described. The description of noise intensity and frequency was too brief to be informative. In a spinning and/or weaving room noise environment, certain frequencies will be more or less intense according to the noise source. It is not likely that a flat response was obtained at 110 dB for all frequencies between 31.5 and 16,000 Hz.

Health Effects:

CVS Response : Total serum lipids (turbidity method), beta-lipoproteins (Koller method), total cholesterol and its esters (Zlatkis method), and FFA (method of Dole).

Evaluation : Excluded persons with some diseases. Sample sizes were small and nonrandom. Implications that FFA and cholesterol increase with noise exposure are not supported by the design which fails to compare serial changes in the exposed with serial changes in the controls.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Student's test and Student's paired test for the serial data among controls.

Control for Potential Confounders:

Exposed subjects and controls performed work of the same physical effort under the same conditions of temperature and humidity. However, a major problem in the study was failure to control for intraindividual differences in lipid levels by taking serial measurements.

Conclusions:

Authors : ". . .at least two periods can be distinguished in the regulation of lipid metabolism during 8 hour exposure to noise. . . . The 1st period comprises the first two hours of work, during which an increase in cholesterol and beta-lipoprotein concentration, a tendency toward FFA rise, and a slight decrease in total lipids are observed. . . . The 2nd period comprises the time between 6 and 8 hours of work in noise, when a considerable increase in FFA is observed, while the other lipid substances tested in the blood reach values similar to those before the work."

Overall Evaluation:

The study design prohibits appropriate comparisons of lipid levels among noise exposed women and the controls. The changes in lipids which the authors ascribe to noise exposure may be no more than interindividual variation of lipid levels among women of varying age groups irrespective of noise exposure. These cross-sectional data (with no baseline or serial measurements) do not support conclusions of change in lipid levels with change in duration of exposure to noise.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 4
Epidemiologic Method = 1

Citation: Raytheon Service Company: The Effects of a Company Hearing Conservation Program on Extra-Auditory Disturbances in Workers. Prepared for U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health (Contract No. CDC-99-74-28), May 1975. (English)

Researchers and Institution where research performed:
Raytheon Service Company, Burlington, Massachusetts.

Stated Purpose: To determine whether there were fewer record entries indicating extra-auditory problems for workers in noisy jobs subsequent to the establishment of the hearing conservation program, as compared with those found previously on the same workers exposed to high workplace noise (95 dBA or more).

Study Design and Sample:

: Occupational groups working in a plant producing large pressure boilers.

: Before-after comparison of record entries in the worker files for two-year periods just before (1969-1970) and after the start of the hearing conservation program (1972-1973) (a) for those in high noise workplaces by degree of ear protective usage, (b) for workers in the low noise areas for the time periods to provide plantwide variations in problems between the two time periods and (c) for the extent of the differences in the prevalence of extra-auditory problems between the two groups prior to and following the hearing conservation program.

Data Sources : Extant employee medical records and noise survey data.

Bias Potential in Design:

: Potential problems of invalidity of the quasi-experiment relative to history and aging of subjects, regression to the mean, selection, mortality and changes in instrumentation for measurements.

: Placebo effect may be operating and cannot be controlled in this design since subjects were not randomized into hearing conservation and types of ear protector groups, but all noise exposed workers became the intervention group.

Noise Exposure:
Noise Description:

Source : Boremills, machinery centers, arc-air flame cutting devices, air compressors, heavy presses, peg-cutting machines, large automatic panel welding machines, chipping hammers, grinding machines.

Type : Industrial noise used in production of large pressure boilers; (unsteady).

Frequency Composition: Not reported.

Levels : Actual noise levels reported for 75 job titles; taken during ear protection phase of study; for subject categories high noise = 95 dBA or greater and low noise = 80 dBA or less (measured ambient noise).

Duration of Exposure: Based on working days and absences. Duration of exposure could be highly variable as nonsteady noise is typical for many of the sources. For the years 1969-1970 there was no ear protection and for 1972-1973 all workers in high noise area had ear protection available. Charts show attenuation characteristics of the ear protectors but no attenuation measures were taken during 1972-1973. The intervention measure, use of ear protection, was rated as "always", "frequently", "infrequently" or "never" based on the composite judgment of plant safety director, line foreman and investigator. A second measure used was a rating of "yes" if observed wearing the protector by the project director or "no" if observed not wearing the protector.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; four manufacturing plants: Power Boiler, Nuclear Components, Tube Mill and Superheater plants. Facility layouts with workers at their stations. Exact relationships of workers to noise sources are not clear for all subjects.

Subjects : Amount of experience at present job explored, but possible exposures related to other jobs were not considered; no reports of avocational noise exposure; hearing thresholds obtained before hearing conservation program and after the program. By January 1972, all workers in 90 dB or greater areas were fitted with ear protection (muffs or inserts). All workers in these noise areas were tested at least annually at "six discrete frequencies in each ear" 500, 1000, 2000, 3000, 4000 and 6000 Hz. There were no significant shifts for those wearing ear protection. One presumes there were otological examinations and the history of ear disease was considered.

Evaluation : Frequency composition of noises were not reported, nor was the noise measurement procedure or instrumentation; the exact relationship of workers to the noise in their environment is questionable; ambient noise levels vary considerably depending on the total number of machines and equipment used in a specific work area; no exploration of avocational noise exposures. Investigators question the methods used to gauge ear protection, then state that because hearing showed no further deterioration during ear protection period, there is evidence that ear protectors were worn.

Health Effects:

CVS Response : Diagnosed medical problems and symptoms reported by the worker; nine diagnostic categories including cardiovascular, neurological, otological, respiratory, etc. Coders were "blind" to the exposure conditions.

Evaluation : Diagnoses made by physician but no diagnostic criteria are given and no breakdown into specific disease categories. Some of the diagnoses used in the examples are questionable relative to a chronic clinical state (hypertension and hemotrypsia). Significant differences in age groups between the high and low noise groups resulted in very small numbers of problems when considered by age. Cardiovascular diagnoses decreased overall; while major decreases occurred in the 46-55 year group, there was also a decline in the < 26 year age group which usually has a low incidence of cardiovascular problems. The major limitation of the CVS data is that of diagnostic weakness.

Judging Causal Significance:

Strength of the Association: Not reported.

Statistical Methods: The Wilcoxon Matched-Pairs Signed Rank Test for individuals serving as their own controls; the Median Test for comparing the low noise versus high noise groups.

Dose-Response Relationship: Observed if consider degree of ear protection usage as levels of exposure; workers judged to have always used their protectors showed the greatest reduction in frequency of all medical problems relative to their pre-hearing conservation dates, while those rated as never using their protectors showed the smallest relative change. However, this relationship failed to appear within the age categories and was not apparent in the data specific to diagnosed cardiovascular problems. Thus, the dose-response data must be interpreted with caution.

Control for Potential Confounders:

Major variables considered in the analysis were worker age, length of service, job type and work shift. There is no indication that previous medical history or use of outside medical services were explored.

Conclusions:

Author : "Expected relationships between rated usage of ear protectors and incidence of extra-auditory problems were orderly in some cases, but not in others. Methodological shortcomings in determining ear protector usage may have been responsible for this result....In general, the results were seen as adding strong support to the hypothesis that prolonged exposure to high intensity noise increases the incidence of various medical, accident, and attendance problems, and that a hearing conservation program can be beneficial in reducing these problems as well as hearing loss risk."

Overall Evaluation:

This study provides limited support to the hypothesis that exposure to noise increases the incidence of medical problems including cardiovascular. The methodological shortcomings in determining ear protector usage and specifying diagnostic criteria for determining health problems coupled with the relatively small sample and short follow-up period make interpretations of the data difficult.

For all medical problems, there was a demonstrated effect difference in the high noise group from period 1 to period 2, but there were also differences from period 1 to period 2 in the low noise group without ear protection suggesting further exploration of environmental factors may be in order. The data may have been presented in more succinct form to make comparisons easier. All in all, this is an intriguing study, capitalizing on the use of extant data of such a nature that it provided opportunities to examine interaction of a number of salient factors in the work environment.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 6
Epidemiologic Method = 5

Citation: Semczuk, B. and Gorny, H.: Studies on the Effect of Noise on Cardiorespiratory Efficiency. Polish Medical Journal 10(3): 594-598, 1971. (English)

Researchers and Institution where research performed:
Department of Otolaryngology, Medical Academy in Lublin.

Stated Purpose: Present results of studies on the effect of noise on cardiorespiratory efficiency.

Study Design and Sample:

: Healthy men observed under conditions of professional work in noise and in an experimental clinical situation.

: Sample of 200 healthy men aged 35-45 years.
50 individuals tested during stimulation of auditory organs and 50 individuals (control group) who worked in noise which did not exceed 65 dB; 100 individuals at their work stands where the intensity of noise was 80-115 dB with microclimates similar to the control group, but which were not conditions of climatic comfort.

: Selection criteria not enumerated and size determinations not given.

Data Sources : Apparently primary data collection for this study - not described.

Bias Potential in Design:
Bias due to selection of healthy workers unknown.

Noise Exposure:
Noise Description:
Source : (1) Audiometer; (2) Pneumatic hammer, Shot-treatment, Smithy hammers and Compressors.
Type : Audiometer tones, steady; industrial noise, non-steady.
Frequency Composition: (1) Audiometer: 500, 1000, 2000 and 4000 Hz; (2) decibel intensity versus frequency (31.5 to 35,500 Hz) graph in Figure 1.1 shows intensity as a function of frequency.
Levels: (1) Audiometer 100-110 dB; (2) 80-115 dB "on the average," specific levels plotted on graph (Figure 1.1).
Duration of Exposure: (1) 40 seconds with a "few minutes interval" between stimuli; however, number of 40 second exposures not reported, confusing; (2) 7 A.M. to 3 P.M. = 8 hours.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : (1) Controlled; acoustic "darkrooms" of the department, ? soundroom. (2) Uncontrolled; at work stands on the job; relationship of noise sources to workers not described.
Subjects : History of vocational and avocational exposures in "healthy men", riveters, varnishers, blacksmiths, locksmiths, solderers and sanddiggers not given. Hearing thresholds and history of ear disease not reported; "normal auditory organs" implies otological exams were performed.

Evaluation : Article not precise as to amount of noise exposure experienced by subjects or relationship of noise sources to subjects. Methods and procedures on p. 595 confusing; the word "noise" in the sentence separated by Figure 1.1 could refer to pure tone "noise" stimuli as well as work related noise.

Health Effects:

CVS Response : CRIS - index of cardiorespiratory efficiency, made up of vital capacity, apnea (breath-holding) and heart rate. A decrease in CRIS implies decreased efficiency.

Evaluation : In all (most?) cases the vital capacity did not change, but apnea time decreased and/or heart rate increased. Apnea time is very much affected by subjective factors (concentration). Controls seem adequate. Clinical significance of CRIS and disease is unknown and unstated. No data given to indicate it is a significant indicator or risk of cardiovascular disease.

Judging Causal Significance:

Strength of the Association: Not given.

Statistical Methods: Not stated, although significant findings reported. Apparently no allowances for regression to the mean in testing for differences in CRIS.

Control for Potential Confounders:

No controls on age, length of exposure, socio-economic status and other risk factors. Control group of 50 and 100 individuals tested at work site were in similar temperature, humidity conditions. Wearing of ear protectors not reported.

Conclusions:

Authors : "In 73% of the examined individuals after 8 hours of work in noise of 90-115 dB intensity the CRIS value decreased by 2-8, on the average, while in a control group of 50 persons who worked in much less intensive noise (65 dB) such changes were not observed....This may be an additional proof that the investigated changes of the cardiorespiratory index... are due to strong and long lasting acoustic stimuli."

Overall Evaluation:

The clinical significance of the health outcome measure is very questionable. Failure to control for potentially strong confounding variables reduces the usefulness of the findings. This study contributes little to the understanding of the relationship of noise exposure to cardiovascular response.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 2
Epidemiologic Method = 3

Citation: Takala, J., Varke, S., Vaheri, E. and Sievers, K.: Noise and Blood Pressure. The Lancet 2:974-975, November 5, 1977. (English)

Researchers and Institution where research performed:
Takala - Department of Public Health, University of Tampere, Tampere, Finland.
Varke - Department of Public Health, University of Turku.
Vaheri - Institute of Occupational Health, Helsinki.
Sievers - Department of Public Health, University of Helsinki.

Stated Purpose: None; implied comparison of mean BP of men with a hearing defect of noise-exposure type with mean BP of men with normal hearing. Cites Jonsson and Hansson's finding of an association of BP and hearing loss; implied replication study. However, states data were obtained in 1973-1974.

Study Design and Sample:
: Community survey, screening program in 1973-1974 of a middle-aged population.
: Cross-sectional design.
: Sampling methodology not given. 93% participation rate.
: Data provided for men aged 40-59.
: Sample of 32 men, whose work exposed them to noise and who had impaired hearing of noise exposure type with a threshold of hearing 65 dB or more at 4000 and 6000 Hz; 67 men with normal hearing, threshold at all tested frequencies 20 dB or less, exposure to noise not given.

Data Sources : Screening program with all inherent biases.

Bias Potential in Design:
Selective survival, migration bias, problems in ascertainment of total group at risk.

Noise Exposure:
Noise Description:
Source : No data given except for selecting individuals with and without hearing loss.
Type : Not specified, other than subjects "whose work exposed them to noise."
Frequency Composition: Not given.
Levels: Not stated.
Duration of Exposure: Not specified.
Instrumentation: Not specified.
Measurement Procedure: Not specified for noise parameters nor for hearing acuity measures.
Environment : Not specified.
Subjects : Vocational noise exposure, history of avocational exposure, history of ear disease, otological examination were not specified. Hearing thresholds obtained after noise exposure. A screening level of 15 dB used and then threshold determined at 500, 1000, 2000, 4000, 6000 to 8000 Hz.

Noise exposure type hearing loss defined as threshold of hearing 65 dB or more at 4000 and 6000 Hz; normals as thresholds of 20 dB or better.

Evaluation : Poor relative to noise, as no descriptive data regarding noise parameters or measurement were provided.

Health Effects:

CVS Response : Single BP reading; right arm; mercury manometer; subject sitting for 3-5 minutes with cuff on arm, accuracy of 2 mm. Hg.; 5th phase DBP recorded; subjects had BP tested after 45 minutes rest; hypertension defined as > 160/100 mm. Hg. Personnel trained in BP measurement. BP observer masked to audiometric results.

Evaluation : Adequate for community survey. Temporal relationships of "exposure" to development of health effects poor for judging causality. Individuals under antihypertensive treatment apparently were not excluded.

Judging Causal Significance:

Strength of the Association: No effect parameter specified.

Statistical Methods: Student's t test - neither the mean systolic nor the mean diastolic pressure readings showed statistically significant differences between the normal hearing and noise defect group. However, BP was observed to be higher in the hearing loss group which was also significantly older than those with normal hearing.

Control for Potential Confounders:

No confounders including age were taken into consideration.

Conclusions:

Authors : The authors recognized some of the problems inherent in the data and essentially made no inference about effects; "coincidence of high blood pressure and a hearing defect of a noise-exposure type is not sufficient evidence of a causal relationship."

Overall Evaluation:

Study contributes little to assessing the effects of noise on the cardiovascular system. There is no description of the noise, and methodology and findings are described too briefly to evaluate well.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 8
Epidemiologic Method = 4

Citation: Yazburskis, B.I.: Effect of Ultrasound and Noise on the Cardiovascular System of Operators of Powerful Acoustic Units. Hygiene and Sanitation (Gig. Sanit.) 36(3):105-107, 1971. (English)

Researchers and Institution where research performed:
Clinic of Occupational Diseases of the Erisman Research Institute of Hygiene, Moscow.

Stated Purpose: Studied the responses of the cardiovascular system to low frequency sound among scientific personnel, laboratory technicians and workers operating powerful acoustic units, viz., emitters of 8, 18 and 20 kc with outputs of 98-106 db.

Study Design and Sample:

: Quasi-experimental - experiments in an ultrasonic laboratory under work conditions.

: 36 healthy laboratory workers (21 men, 15 women) divided into three groups:
10 people operating an ultrasonic disperser of 20 kc with power output of 160 db;
14 operators of 18 kc emitter, with power output up to 100 db;
12 operators of 8 kc emitter, with power output up to 132 db.

: No criteria for sample selection or assignment to groups.

: Subjects wore ear plugs during experiments.

Data Sources : Primary data collection.

Bias Potential in Design:

: No control group may lead to spurious conclusions.

: Low frequency ultrasound misclassified. Range of 8 kc-20 kc is within hearing range. (Above 20 kc is ultrasonic.)

: Subjects wore earplugs which may have affected, in varying degrees, the intensity level of noise arriving at the ear.

: Membership and selective reporting bias may operate since subjects had been working with ultrasound for 2-5 years.

Noise Exposure:
Noise Description:
Source : (1) A "RUZ" ultrasonic disperser of 20 kc, (2) an emitter of 18 kc, (3) an emitter of 8 kc.
Type : "Low frequency ultrasound."
Frequency Composition: (1) 20 kc, (2) 18 kc and (3) 8 kc.
Levels: (1) Up to 160 db, (2) up to 100 db and (3) up to 132 db. "Up to" allows a wide variation and is not specific enough for studies of sound effects.
Duration of Exposure: "4-5 hours a day." Also "most" of the subjects reportedly had been working with ultrasound for 2-5 years.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Not described; "ultrasonic laboratory."

Subjects : No data as to long-term histories of noise exposure, hearing thresholds, ear disease, etc.

Evaluation : Although noise description was strongest area of this study, it was lacking information. Author misclassified noise as ultrasonic when it (8 kc to 20 kc) was within range of normal hearing.

Health Effects:

CVS Response : ECG and blood pressure. Measured changing amplitudes of P wave, T wave, Q and S waves during the day. No controls and no allowance for changing voltages associated with electrode impedance changes. No criteria for "abnormally large T wave" given. Definition of ST change of "ischemic" type not defined except as 1-2 mm. depression. No definition of QX. "Objective ECG data" do not have any meaning when related to subjective feeling of "constriction or palpitations" since no irregularities of heart beat noted.

Evaluation : No data available on the significance of change in decreased BP, decreased heart rate, changes in amplitudes of P, Q, T waves. The significance of QT-TQ ratio change or its meaning is unknown. Risk evident in delay in "recovery" after the Master's exercise tolerance test is unknown. No controls were used. The "junctional" (conjunction) ST depression observed toward the end of the test is not a significant CV response. The P wave change compared to the "physical" effect is interesting, but may be just that, a difference due to sedentary versus activity response.

Judging Causal Significance:

Strength of the Association: None provided.
Statistical Methods: Not given.

Control of Potential Confounders:

No evidence of randomization into groups or statistical control of variables.

Conclusions:

Author : Workers engaged in the operation of high-power acoustic units displayed reduced heart rate, enlarged T wave, diminished P and R waves and reduced systole:diastole ratio. Exercise caused a downward shift of the RS-T segment of the ischemic type immediately after work with ultrasound. BP fell towards the end of the workday and did not return to its initial level 5 minutes after an exercise tolerance test in all groups. The workers complaints were correlated with the RECG data. "The result suggests that low-frequency ultrasound and sounds of high intensities (100-160 db) are nonspecific stimuli that are liable to produce changes in the activity of the cardiovascular system, apparently without going through the auditory organs....An important conclusion is that the cardiovascular responses evoked by ultrasound and high-intensity noise are directly opposite to those produced by physical work."

Overall Evaluation:

Quasi-experimental design of industrial workers offers little in support of an etiologic hypothesis because of misclassification of noise exposure, lack of controls on external comparisons and rather sketchy and vague presentation of data.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 2
Epidemiologic Method = 2

Citation: Andrukovich, A.I.: The Effect of Industrial Noise in Spinning and Weaving Factories on the Arterial Pressure of Operators. Gigiena Truda i Professional'nye Zabolevaniia 9(12):39-42, 1965. (Russian)

Researchers and Institution where research performed:
State Hospital, Russia.

Stated Purpose: To study dynamics of the arterial pressure in workers of spinning and weaving factories.

Study Design and Sample:

: Female workers in a Bendery Silk combine and textile-weaving factory.

: Cross-sectional comparison of workers compared to the population from which they were drawn; no evidence of true control group.

: Sample of 846 operators of spinners and weaving machines within the ages of 16-49 years, and 1-5 years employment with blood pressures compared to the mean age-specific indices in a female population of 8972 in the given geographic area.

Data Sources : Extant records from successive comprehensive physical examinations in the autumn and other seasons between 1959-1963.

Bias Potential in Design:
No real control group available, selection bias (both noise exposed and local population appear to have unusually low mean blood pressures); potential attrition bias during follow-up from 1959-1963. It is unclear as to whether each of 846 operators was assessed each year or whether the sample represented multiple cross-sectional samplings of the same population of workers over the five years.

Noise Exposure:
Noise Description:
Source : Semi-automatic machines VKR-49 and SP-50, winding machines VKR-49 and SP-50 and "Textima".
Type : Machine noise in a textile weaving factory.
Frequency Composition: "High frequency noise" with no actual frequency components reported.
Levels : In weaving sections 99-102 dB; in spinning sections 87-88 dB.
Duration of Exposure: Employed 1-5 years. Subjects worked over three shifts while standing and periodically moving from one machine to another. Shifts undefined.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Work sites in textile weaving factory; uncontrolled. Layout of noise sources in relation to workers not described.
Subjects : History of other employment in noise occupation not reported. No information provided as to history of avocational noise noise exposure, ear diseases, hearing thresholds.

Evaluation : Information regarding frequency components of noise, duration of exposure to noise, instrumentation and measuring procedure is lacking in this study. It is not clear that the noise/vibration, light and dust content of the spinners and weavers are comparable.

Health Effects:

CVS Response : Arterial blood pressure measured (4-8 times, ? from 1959-1963) by the acoustic method of Korotkov-IAnovskii with Riva-Rocci mercury manometer, 15-20 minutes after leaving work on first shift. Hypertension defined as 140/85 mm Hg.; hypotension defined as ≤ 90/50 mm for the 16-19 year group and ≤ 100/60 mm for the 20-49 year age group. No information provided as to how blood pressure values for the age-sex-specific general population were obtained for the study period 1959-1963.

Evaluation : Total population and study population present remarkably low systolic and diastolic pressures. No information given as to quality of the measurements or training of the observers. Method for selecting and/or averaging pressures for classifying as hypo or hypertensive is not explained.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively.

Statistical Method: Groups compared on proportions with hypertension and hypotension. If the same group of women was examined at successive intervals over the five year period and there were comparable control measurements, a trend analysis may have been more informative than proportional comparisons. Method of analysis is unclear. No statistical tests provided.

Control for Potential Confounders:

Age controlled by stratification into five year age intervals. Family history, weight, treatment, co-morbidities not considered.

Conclusions:

Author : "Arterial pressure was higher in female weavers compared to the mean age-specific indexes for arterial pressure in women of the control."..."The processing of the data obtained demonstrated the statistical significance of the higher levels of the systolic pressure within the age groups 16-19, 30-39 and 40-49 years."

Overall Evaluation:

This cross-sectional study of the effects of noise on blood pressure in a population with remarkably low pressures, may have been more useful had the author provided information as to the selection and assessment of the control population of 8972 women. Although it is stated that there was no statistical difference in arterial pressure between the spinners and weavers where the noise levels varied, it would have been interesting to see if there was any gradient in blood pressure response between these groups of workers and the general population control.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 6
Epidemiologic Method = 1

Citation: Barhad, B., Gradina, C., Mihaila, I., Deculescu, F., Marinescu, V., Cristecu, I. and Miclescu, S.: Investigations on the Effect of Industrial Noise and Vibrations on the Body. Ergonomics and Machine Design, Vol. II, International Labor Office, Geneva:727-734, 1969.

Researchers and Institution where research performed:
Institute of Hygiene, Bucharest, Rumania.

Stated Purpose: To demonstrate the changes in the cardiovascular system, the motor analyzer and the nervous system, as well as those of the auditory analyzer, at the time of work operations accompanied by noise and vibrations.

Study Design and Sample:
: Workers at the smelting division of a large ironworks.
: Cross-sectional pre-post shift design using subjects as their controls.
: 132 workers exposed to noise during the working day; no non-exposed controls or replication of study under non-noise conditions; length of work day not stated.

Data Sources : Not specified.

Bias Potential in Design:
Can only judge short-term effects from these data; intra-individual variation may account for much of the difference attributed to noise.

Noise Exposure:
Noise Description:
Source : Smelting shop; actual machines and sources not identified.
Type : Noise due to smelting in an ironworks plant with superimposed background noise; not reported as steady or nonsteady.
Frequency Composition: Spectrum extending over several octaves (Hz given by authors but available copy too poor for translation).
Levels : Between 98 - 127 dB.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; smelting division; relationship of workers to noise sources was not reported.
Subjects : 100 of the 132 workers had been employed in the smelting division more than five years. No data provided as to other job exposures, avocational noise exposure, hearing thresholds or ear disease.
Evaluation : Study is very poor in specification of noise parameters and especially poor in failure to indicate sources of noise relative to actual noise intensity each would produce at the subject's ear.

Health Effects:

CVS Response : Systolic and diastolic blood pressure; pulse rate; digital plethysmography to assess condition of central nervous system; motor analyzer functions tested by the coordination-rhythm-strength test; auditory analyzer; and new cases of disease.

Evaluation : No information provided as to diagnostic criteria, definitions, measurement procedures, conditions of subjects at time of measurements or time (other than pre and post work) during the day the assessments were made. Clinical significance of measurements recorded is unknown.

Judging Causal Significance:

Strength of the Association: Not available from before-after measures because no control group comparisons were made; cross-sectional comparison of new (no time relationships stated) cases of disease showed workers in the smelting division to have 1.9 times as many respiratory diseases and 1.26 times as many circulatory diseases as workers in the motor division (? drivers). No data for determining dose-response.

Statistical Methods: Data presented as percentages; no inferential statistical tests stated.

Control for Potential Confounders:

No evidence of control for age, sex, weight, co-morbidities, physical exertion, hearing levels or intra-individual variation.

Conclusions:

Authors : "...under the effect of work carried out in noise...most of the workers showed toward the end of the work day a decrease of the systolic and diastolic pressure which varied between 7 and 14 mm Hg. compared to the values found at the beginning of work."..."The study of the clinical and statistical morbidity of smelting division workers shows, in relation to workers in the motor section, a significantly higher disease rate" [1.26 for circulatory disease]...."Our results show that, under the influence of noise and vibrations, changes appear which are shown by disturbances of the functional condition of the entire organism, and not only of the auditory analyzer."

Overall Evaluation:

Study provides poor information for assessing long-term extra-auditory noise effects. There is no information given about sampling, intra-individual variation of values, quality control of exposure or response variables. There was inadequate statistical analysis with no controlling for confounders.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 0
Epidemiologic Method = 3

Citation: Britanov, N.G.: Effect of Noise and Acetone on Female Workers in Acetate and Polyvinyl Chloride Fiber Factories. Gigiena Truda i Professional'nye Zabolevaniia 2(12):15-19, December, 1979. (Russian)

Researcher and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases of the U.S.S.R. Academy of Medical Sciences.

Stated Purpose: To study the combined effect of noise and acetone, a widespread toxic substance belonging to the first category of narcotics.

Study Design and Sample:

: Female employees in acetate and polyvinyl chloride chemical fiber factories, working under varying chemical and noise conditions.

: Cross-sectional comparisons of three groups:
Group 1. Workers of spinning sections with noise at maximum permissible level (MPL) and acetone at maximum permissible concentration (MPC) ($200mg/m^3$).
Group 2. Workers of warping section of acetate fiber factory, with noise lower than MPL and acetone at the level of MPC.
Group 3. Workers of the rewinding and twisting sections where noise was at the MPL or higher and acetone 3-6 times lower than MPC.

: Total sample of 113 women, ages 23-49 years with 6-10 years of employment. Blood analysis run on 101.

: Completeness of sample and reasons for preceeding exclusions/losses not given.

: Numbers of workers within each of the comparison groups not given.

Data Sources : Safety studies in the plant and detailed medical examinations by a team from the Institute of Occupational Hygiene and Occupational Diseases of the U.S.S.R. Academy of Medical Sciences.

Bias Potential in Design:
Unable to determine the potential degree of selection and non-response bias. Sample size small and of unknown variability within groups for investigating hypertension. Limited combinations of noise and acetone environments are inadequate for estimating all possible interactive effects if this were desirable.

Noise Exposure:
Noise Description:
Source : Spinning, warping, rewinding, twisting machines.
Type : Continuous, wide-band, industrial noise; "energy domination in the region of medium and high frequencies."
Frequency Composition: Spectrum of noise plotted for frequencies versus dB level in six sites within factories.

Levels : Not uniform in the various sections. Chart shows 63 to 8000 Hz and approximately 50 to 100 dB ranges for plotting. Most intense noise in spinning section of acetate factory (approximately 90 dB from 125 to 2000 Hz according to the chart) and in the twisting section of both plants (chart shows approximately 98 dB rising at 63 dB which indicates noise may have been even more intense at lower frequencies.)

Duration of Exposure: Questionable; workers moved from one machine to another continuously. Most of the subjects had been employed 6-10 years.

Instrumentation: B & K noise meter used for measuring noise.. Compliance with Standards not stated, however, all B & K equipment is high quality.

Measurement Procedure: Not described; states that noise was measured by generally adopted methods.

Environment : Uncontrolled, acetate and polyvinyl chloride chemical fiber factories. Noise sources relative to workers not described.

Subjects : Hearing thresholds obtained before work, three hours after work and after leaving work. Otolaryngologist performed otological examination, but history of ear disease not reported. No information provided on history of avocational noise exposures.

Evaluation : This study of the combined effects of noise and acetone failed to report information in detail. B & K noise meter is an insufficient descriptor although it implies adequate instrumentation. Maximum permissible noise levels for subjects referenced to GOST 12.1.003-76, but levels were not reported. The actual duration of exposure to noise is questionable since workers continuously moved from one machine to another.

Health Effects:

CVS Response : Frequency of complaints including pains in the heart region and weakness with increased fatigue.

: Arterial blood pressure with WHO definitions used to define hypertension. For adults, borderline hypertension defined as BP in the range 140/90 - 150/95 mm Hg.; lower levels considered normal and hypertension defined as arterial blood pressure of 160/95 mm Hg. and higher.

: Also included were physiological studies and hearing tests. Definition of static work endurance as equal to heart rate response to isometric exercise, 30% of maximum, is questionable.

Evaluation : No information provided as to whether or not blood pressure and complaints were assessed blind to the noise exposure of subjects, the number of observers, the standardization of the questionnaire, or the equipment and procedures used in taking blood pressures. Time BP was taken is not stated.

Judging Causal Significance:

Strength of the Association: Not stated as such, but reports hypertension and borderline hypertension as 30% in Group 1, 27.5% in Group 3 compared to 9.7% in the low noise group (Group 2) for a prevalence ratio of approximately 2.8.

Statistical Methods: No evidence that statistical tests were applied to the data.

Control for Potential Confounders:

Author states "to exclude the age factor, the results of the observation were standardized", but it is unclear whether standardization was used throughout the analysis or only with the blood analysis. No other potential confounders such as obesity and social class were considered in the blood pressure analysis.

Conclusions:

Author : "1. In workers exposed to the combined effects of noise at the level of MPL or 5-11 decibels higher and to acetone within the limits of MPC, and also in those exposed to the isolated effect of similar noise, functional alterations of the nervous system following the pattern of neuro-vascular dysfunction and neurotic reactions, and borderline and arterial hypertension, were more frequent.

2. Alterations of physiological functions (visual-motor reaction time, endurance of static work) were more pronounced in workers exposed to the simultaneous effects of noise and acetone than in those exposed mainly either to noise or to acetone.

3. Alterations of the hearing sensitivity during a work shift reflect the effect of noise."

Overall Evaluation:

Prevalence data, although not subjected to statistical analysis, offers suggestive evidence of an association between hypertension and noise level. Weaknesses of the study include lack of evidence of quality control of the data, potential self-selection and possible confounding by many environmental variables.

(Scores on a scale of 0-9)

Noise Exposure = 5
Health Effects = 3
Epidemiologic Method = 2

Citation: Burger, F. and Klimes, J.: Changes of Some Physiological Factors During Physical Work Under the Impact of Noise. Vojenske Zdrayotnicke Listy 44(1):32-37, 1975. (Czechoslovakian)

Researchers and Institution where research performed:
District Unit of Hygiene and Epidemiology, Ceske Budejovice.

Stated Purpose: To test the classic methods by which physical performance is determined in sports physiology, and observe the changes of indicators which occur when the subjects are exposed to noise.

Study Design and Sample:

: Quasi-experiment of 20 untrained conscripts aged 19.3 ± 0.9 and divided into two groups:
(1) half exposed to short-term noise pressure in the course of a 20-minute workout on a bicycle ergometer with a one-stage weight of medium intensity (600 kpm/min) and acoustic pressures of 90, 100 and 110 dB;
(2) half exposed for 2 hours to acoustic pressures of 80 and later 100 dB, both with same spectrum; bicycle ergometer series of 2 ascending, less-than- maximal weights of 600 and 900 kpm/min at 60 revolutions a minute, 6 minutes for each degree of weight, with a one minute break between.

: Observations during first 5 minutes of recuperation.

: Tests conducted in the Latin square to avoid habituation; subjects were pretested under no noise conditions.

Data Sources : Experiment.

Bias Potential in Design:
Selection bias possible; effects may have been confounded with groups if replication sets of respondents were not assigned different specific Latin squares which probably was not possible with the small subject pool and short series of experiments.

Noise Exposure:
Noise Description:
Source : The noise of tank motors with a known spectrum, recorded and conveyed to the experimental room by two loudspeakers.
Type : Tank motor noise (recorded); steady noise presumed on the basis of precise levels reported.
Frequency Composition: States noise of known spectrum, but components of the spectrum not reported.
Levels : 10 subjects - short-term: 90, 100, 110 dB;
10 subjects - long-term: 80, 100 dB.
Duration of Exposure: Short-term: 20-minutes during workout; long-term: 2 hours.
Instrumentation: B & K Band Analyzer with the characteristic A, probably meaning noise level measured on A scale.
Measurement Procedures: Not reported.
Environment : Controlled; laboratory conditions in an experiment.

Subjects : No information about conscripts provided other than age of 19.3 years. No history of vocational or avocational exposures, or ear disease. Hearing thresholds apparently not obtained.

Evaluation : Although authors report a known spectrum, the frequency composition of the noise was not reported. Noise measurement procedures and subject characteristics were not described.

Health Effects:

CVS Response : Oxygen consumption, ventilation, pulse frequency with EKG evaluated with a one-channel electrocardiograph.

Evaluation : Experiment demonstrated a decreased pulse rate response and increased P wave amplitude with high noise levels. While a decreased pulse rate may indicate parasympathetic arousal, the significance of the P wave changes is unclear and probably does not imply myocardial metabolic effects as suggested by the authors.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively.
Statistical Methods: Test of pairs.

Control for Potential Confounders:

Sample of questionably small size to adequately control for potential confounding within the quasi-experimental design.

Conclusions:

Authors : "Even though our experiments allow the conclusion that a decrease of physical ability does not occur, it is, in view of its effects upon the circulatory system, impossible to affirm unconditionally that exposure to noise is completely harmless to the organism."..."but that its negative effects will become manifest after an exposure lasting a number of years. The use of protectors against noise does not prevent its effects upon the circulatory system."

Overall Evaluation:

This quasi-experiment is weak in that it did not involve sufficient numbers of groups to make possible random assignment of intact groups to treatments as a better means of control. These data are insufficient to warrant inferences as to effects after noise exposure lasting years. The study is of interest because it simulates industrial noise, suggests to the authors that possible adaptive mechanisms may reduce the threshold of stimulation at high levels of long-term exposure and shows that while ear protectors may protect hearing, they did not prevent the effect of noise upon pulse frequency.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 9
Epidemiologic Method = 4

Citation: Capellini, A. and Maroni, M.: Clinical Investigation of Arterial Hypertension and Coronary Disease and the Possible Relationship with the Work Environment in Workers of the Chemical Industry. Med Lavoro 65 (7-8):297-305, 1974. (Italian)

Researchers and Institution where research performed:
Occupational Health Clinic "L. Devoto" of the University of Milan, Italy.

Stated Purpose: To investigate the possible risk factors for the cardiovascular pathology in relation to work activity.

Study Design and Sample:
: Occupational groups in a chemical industry near Milan.
: Cross-sectional data.
: 1286 men and 60 women representing 98.6% of the factory employees responded and were categorized into four age groups: ≤ 35 years old, 36-45 years, 46-55 and over 55 years of age. Considering 11 characteristics of the environment and of the type of work, each homogeneous group was evaluated for disease frequency.

Data Sources : Screening program in a factory with diagnostic follow-up of 180 suspected of having disease

Bias Potential in Design:
Selective survival recognized by authors. Sample size of women too small for controlling for sex. Description of design too scanty for evaluating the adequacy of the "homogeneous groups" used in the analysis. No indication of the number of workers exposed to noise and not exposed nor their characteristics.

Noise Exposure:
Noise Description:
Source : "In laboratories of chemical industry"; sources not reported.
Type : Chemical industry noises; not specified as to steady or non-steady.
Frequency Composition: Not reported.
Levels : Not reported.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; positions of workers relative to noise not described.
Subjects : History of vocational, avocational noise exposure, and ear disease not reported. Hearing thresholds of workers not reported.
Evaluation : Although investigators report intense noise - on the order of 85/95 dBA was significantly correlated with disease, all noise parameters and important subject criteria were ignored. It was inferred that evaluations of noise exposure were indexed in semi-quantitative terms based on periodic

instrument samplings; a subjective determination was made for work positions where samplings were not available.

Health Effects:

CVS Response : Hypertension defined as SBP higher than 160 mm Hg. and DBP higher than 90 mm Hg., confirmed with at least two measurements repeated on several days by cardiology specialists. Coronary disease: myocardial infarction, diagnosed by specialist on history and/or from EKG and VCG readings; progressive angina pectoris with or without corresponding EKG's at rest and under stress; positive exercise stress test defined by exercise precipitated chest pain or abnormal S-T response to exercise (flat or descending S-T or 0.1mm or greater).

Evaluation : Health outcome criteria are well defined, however, numerous confounders are present.

Judging Causal Significance:

Strength of the Association: Not reported.

Statistical Method: Chi-square and weighted regression with prior logistical transformation of the disease frequency. Unable to determine temporal relationships of the variables from the correlational data. No evidence provided of dose-response relationship.

Control for Potential Confounders:

Age and shift schedule were identified as confounding the observed associations; the frequency of hypertension by age groups was not significant for any of the 11 factors studied; hypertensive subjects among day workers were clearly older than those among the shift workers suggesting to the authors that hypertensive subjects, especially if elderly, go from shift work to that of daytime work. Using a weighted regression analysis it was observed that the probability of coronary disease in noise exposed workers of a given age group was nearly identical to that of nonexposed workers in the next age group. There is no indication that blood pressure and sex were considered in that analysis.

Conclusions:

Authors : "Our data indicate that the risk quota for coronary disease due to exposure to intense noise is equal to that in the non-exposed population by an increase in age of 10 years. ...On the basis of the indications of this series of research and the results of our investigation, it may be concluded that the hypothesis of an etiological or promoting role of intense noise in the genesis of coronary disease is very probable." No correlations found between hypertension and noise , nor with stress, lighting, temperature, work monotony, vibration, work schedule, pay, physical exertion, high work rhythm.

Overall Evaluation:

The study design and noise exposure variable were described so poorly it is difficult to evaluate this research. Although the sample consisted of 1346 workers, there was no indication of the number exposed to noise and not exposed to noise. The health measurement with verification of the diagnoses and the statistical analysis were the best features of this investigation.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 6
Epidemiologic Method= 1

Citation: Cieslewicz, J.: Attempt to Evaluate the Extra-Auditory Impact of Noise Upon the Workers of a Weaving Mill in the Cotton Industry. *Medycyna Pracy* 22(4):449-459, 1971. (Polish)

Researchers and Institution where research performed:
IV District Outpatients' Industrial Clinic in Lodz.

Stated Purpose: To determine if there is a causal relationship between excessive noise levels and the occurrence of certain diseases among the workers at the mill (weaving and spinning).

Study Design and Methods:

: Occupational groups in weaving and spinning mill in Poland; in weaving 490 women and 212 men; in spinning 353 women and 252 men; workers categorized into age groups of 18-29, 30-39, and 40-49.

: Cross-sectional study conducted in 1968-1969.

: 702 weavers exposed to noise exceeding the ISO hygienic norm of N=85 (values ranged N=96-116) compared to 605 spinners exposed at the 84-90 dB. Weavers used their own ear protectors and stopples and were exposed to a hot climate and cotton dust in the air within the norms. Spinners were organized in three shifts with a weekly rotation and in certain areas were exposed to dust pollution exceeding the NDS norms.

: No information provided as to completeness of sample or data missing from personal files.

Data Sources : Periodical medical examination data from personal files of workers, "together with other information concerning disease, work disability, social and housing conditions and the particular microenvironment at work." Noise tests conducted by a team from the Institute of Occupational Medicine at Lodz in April 1969.

Bias Potential in Design:
Selection bias, selective survival and measurement bias are likely given the data sources, design and discussion by the author. In the weaving department, the hypertension rate increased when taking into account workers transferred, resigned and with disability pensions; in the spinning department workers with health problems were routinely transferred to less demanding jobs whereas weavers were not. Also the criteria used in hiring new workers were believed to contribute to lower disease frequency - years of employment not given for spinners. The population samples and their work environments simply were not comparable on many variables (age, sex, years worked, transfer practices, dust levels, temperature, etc.). Prevalence data does not allow determination of temporal relationship between noise exposure and health conditions.

Noise Exposure:

Noise Description:

Source : Not specifically reported; noises in weaving and spinning mill.

Type : Industrial; not reported as to steady or nonsteady.

Frequency Composition: Figures presented show frequencies 31.5 to 8000 Hz components with highest levels in 500, 1000 and 2000 Hz range for the weaving rooms. Based on the figures, it appears that noise extended above 8000 Hz, the highest frequency reported. No data provided for spinning rooms.

Levels : Plotted for weavers; noise exceeded the (ISO norm) N 85 curve for octaves 250-8000 Hz, yielding values N=96-116.

Duration of Exposure: Not reported other than in years employed; most workers in weaving had worked 15 years or more in the mill.

Instrumentation: Not reported.

Measurement Procedure: Not reported, however, from the figures showing the noise values it is presumed that measurements were only taken in the center of weaving rooms. Compliance with standards not reported, measurements were made by a team from the occupational institute.

Environment : Uncontrolled, weaving and spinning mill.

Subjects : Only data presented relative to history of vocational noise exposure was that for workers in the weaving department where 44% had already worked 15 years or more in the mill, 16% had worked less than 4 years; 21% for 5-9 years and 19% for 10-14 years. History of avocational exposures and ear disease and hearing thresholds were not reported.

Evaluation : Sources of noise and duration of exposure were not reported, nor was the instrumentation and procedure for measuring noise. The noise environments were inadequately described and subject information was lacking. The noise parameter data in general were poor. While both environments apparently had relatively high noise levels, no data were provided for the spinning section.

Health Effects:

CVS Response : Hypertension defined as BP higher than 150/95 mm Hg.; neurotic syndromes indicated by the occurrence of standard symptoms described by Musial and Cwynar and gastric and duodenal ulcers determined by X-ray.

Evaluation : Diagnostic criteria and definition of hypertension specific and adequate for cross-sectional analysis. No information given as to method of measurement or conditions under which blood pressures were taken. Periodic examinations indicate multiple observers and unstandardized techniques.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively but tabled data show for females over 50 years, 35.9% hypertension for weavers compared to 16.1% for spinners; for men over 50 years, 25.9% hypertension for weavers compared to 9.6% for spinners.

Statistical Methods: Chi-square tests employed.

Control for Potential Confounders:

Presented data by age categories. Since spinners and weavers were very disparate on age with weavers being younger but having worked for much longer periods of time than spinners, age and length of employment should have been taken into account together in considering blood pressure effect. Substantial differences were found between men and women in relation to the number of years worked. When the data were adjusted for years employed, the differences in hypertension rates for men and women were not statistically significant. Although the author reports that the position held, housing circumstances, distance between residence and work place and smoking did not have a marked statistical impact on disease frequency, the data were apparently analyzed univariately and for the weavers only. Apparently rotating shifts were not taken into account in any of the analyses. The author reports that individual protective devices used over the years by the workers did not protect them against extra-auditory effects of noise. The workers were ostensibly protected against hearing loss, but no data were provided on hearing thresholds.

Conclusions:

Author : "The analysis of the frequency of illness among the workers of the weaving and spinning (hard waste) mill has shown clearly that hypertension, neurotic syndromes, and gastric and duodenal ulcers are more frequent among the workers at the weaving department. This difference must be connected with the sharply different working conditions of the two groups and, especially, with the extent of exposure to noise pollution."

Overall Evaluation:

Although this study concludes that hypertension occurred more often among people in the weaving department (high noise) than among the people working in the spinning rooms, this conclusion cannot be defended given the cross-sectional study design, the evidence of selection bias and the failure to control in a multivariate sense for the many potential confounders such as age, social class. The strength of the study lies in its potential for consideration of multiple variables in a large group of workers.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 7
Epidemiologic Method = 3

Citation: Demeter, I., Drasoveanu, C., Cherestes, I., Kertesz, I. and Demeter, E.: The Interrelation Between Sonic Trauma and Arteriosclerosis. *Otorinolaringologia* 24(3):197-203, 1979. (Rumanian)

Researchers and Institution where research performed:
City Hospital, Baraolt County Covasna and ENT Clinic of Tirgu-Mures.

Stated Purpose: To look into a possible interrelation between sonic trauma and arteriosclerosis, two pathological entities frequently encountered.

Study Design and Sample:

: 100 male workers in a coal mining enterprise; mean age 45 years and 1-13 years exposure to noise.

: Cross-sectional data.

: Divided workers into 3 groups according to audiometric results:
Group 1 = normal hearing;
Group 2 = incipient sonic trauma;
Group 3 = advanced hearing loss;
Groups 2 and 3 were combined for analysis and included 74 of the 100 workers.

: 40 workers (including all hearing levels) were measured for cholesterol, triglycerides, ophthalmologic exam, ECG's and ponderal index for the performance of additional studies.

: No indication as to how subjects were selected or the total worker group from which the 100 were selected.

: Sample size probably insuffient considering the number of variables investigated and the high prevalence of response variables.

Data Sources : Periodic ENT exams and tonal audiometry one hour after work; complete examination of subgroup of 40 workers.

Bias Potential in Design:
Selection bias potential high - no information given as to sample selection.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Briquette making in a coal mining enterprise; steady or non-steady noise not indicated.
Frequency Composition: Not reported.
Levels : 90-105 dB; however, these levels are questionable if intended to represent levels over 13 years.
Duration of Exposure: Precise exposures for individuals not given; 1-13 years of exposure reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; coal mining enterprise with no further details given.

Subjects : Vocational exposures with coal mining ranged from 1-13 years. No information provided on additional vocational exposures, avocational exposures, nor on history of ear disease. Otological examination and hearing thresholds obtained on all subjects.

Evaluation : Study is inadequate in specifying noise parameters; however, ENT exams and audiometric evaluations were performed.

Health Effects:

CVS Response : Sublingual vessel morphology - Mulfay's method, cholesterol levels and blood pressure measures. No information provided regarding instrumentation or measurement.

Evaluation : No criteria nor definition of high blood pressure given. The validity of sublingual vessel morphology is unknown; its correlation with atherosclerosis is unclear and its presumed relationship is not referenced nor described in any detail.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively; however, on the basis of the data presented one could calculate a relatively high odds ratio of sublingual vessel changes given sonic trauma.

Statistical Methods: Feinstein's set theory with the aid of Venn diagrams. This appears to be a very cumbersome approach to analysis of data utilizing so many variables.

Control for Potential Confounders:

Data available on age, length of exposure, hearing loss, family history, ponderal index, smoking history, hypertension, etc. for at least 40 workers. It is unclear as to which, if any, variables were controlled in analyses of sonic trauma, vascular changes and hypertension other than for the stratification on hearing trauma and categorization into two age groups. The risk factor score for arteriosclerosis included some 9 variables for a final analysis.

Conclusions:

Authors : "1. The noise plays an inducing role in arteriosclerosis.
2. The arteriosclerosis favors the occurrence of sonic trauma.
3. The occurrence of sonic trauma is earlier in subjects over 40 years of age exposed to noise."

Overall Evaluation:

This paper contains the elements of a good study in that it implies the possibility of examining effects of noise on sublingual vessels, blood pressure and cardiovascular risk factors while controlling for age, sex, length of exposure and hearing loss. However, the exposure variable, noise, is poorly documented, and the data do not appear to be examined in appropriate fashion. It is unclear as to what, if any, control or reference group the authors were utilizing. The correlational data presented in this study do not appear to warrant the strong inference reflected in the authors conclusions.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 2
Epidemiologic Method = 2

Citation: Folprechtora-Stenzlova, A., Janicek, M.: The Effect of Noise and Other Factors on Blood Pressure in Workers in Heavy Industry. Ceskoslovenska Hygiena 11(7):394-405, 1966. (Czechoslovakian)

Researchers and Institution where research performed:
District Station for Hygiene and Epidemiology, Olomouc
1st Clinic for Internal Medicine, School of Medicine, Olomouc

Stated Purpose: To study the impact of different levels of acoustic stress upon blood pressure values.

Study Design and Sample:

: Male workers in three foundries producing malleable cast iron and cast steel.

: Cross-sectional comparison of 944 workers divided into group A with noise levels in their work area of 74.8-95.1 dB; group B with noise levels in work area of 107.9 dB, women and technical personnel not exposed to the noisy environment full-time were excluded.

: No information as to completeness of the sample or noise areas studied; no data as to non-response.

Data Sources : Survey measurements of blood pressure and noise measurements, histories collected at time of BP measurement.

Bias Potential in Design:

: Selection into sample, selective survival, selective recall.

Noise Exposure:

Noise Description:

Source ; Equipment which produced malleable cast iron, grey and spheroidal cast iron and cast steel; the only specific sources listed were molding machines and tumbling barrels.

Type : Foundry noise; not reported as to steady or nonsteady.

Frequency Composition: Not reported.

Levels : Group A: 74.8 to 95.1 dB (Lin); average = 92.3 dB (Lin)
Group B: 103 to 124 dB (Lin); average = 107.9 dB (Lin)

Duration of Exposure: Although working exposures were presumed on the basis of years of employment, actual exposures were not reported. Four exposure groups: less than 1 year employment; 1-5 years; 5-10 years; over 10 years exposure.

Instrumentation: Sound Level Meter (SLM), type B & K 2203 and B & K analyzer type 1613. Equipment would meet standard requirements.

Measurement Procedures: Authors report that "the provisional unified method of noise measurement was followed" and cite reference which was not translated; evidently a standard procedure was followed and the measurements made by the Hygiene Division of the Railways of Olomouc.

Environment : Uncontrolled; layout of foundry noise sources relative to worker positions was not reported.

Subjects : Exposures with work in the foundry, but no other vocational exposures considered; hearing thresholds, history of ear disease, history of avocational exposures not reported.

Evaluation : Duration of exposure relative to the level and frequency composition of the noise is not known. One cannot presume one year of a certain amount of noise exposure on the basis of one year of employment. It is not known where the measurements were taken relative to the workers' ear positions. It should also be noted that all noise levels exceeded 74.8 dB.

Health Effects:

CVS Response : Lowest value of three repeated blood pressure measurements used; BP measurements taken on the right arm, subject sitting, toward end of work shift, by Korotkov method, using mercury manometer, by one observer. No evidence of "blinding" of observer to noise exposure status of worker. Average blood pressures of the groups compared.

Evaluation : Used standardized time for recording of blood pressure; classification of level of blood pressure referred to as that of Lehmann, but was not described. Criteria for determining diastolic reading were not reported. No data provided as to health of subjects, previous blood pressure status, medications taken, etc. The average of the blood pressure readings should provide a more accurate diagnosis of hypertension than one arbitrary reading.

Judging Causal Significance:

Strength of the Association: No positive association observed between noise level and blood pressure.

Dose-Response Relationship: Data are suggestive in that workers with a longer exposure (in years of employment) had a higher blood pressure. However, it should be noted that age was only partially controlled. This observation must be interpreted cautiously since age increases with years employed and BP increases with age.

Statistical Methods: Student's t-test to compare average blood pressures of the groups. Group average BP is not a sensitive indicator of hypertensive trends expecially when attempting to analyze multiple potentially confounding variables.

Control for Potential Confounders:

Age and work shift partially controlled. Other potential confounders analyzed singly by age groups of < 40 years and 40 years and over.

Conclusions:

Authors : "Different levels of acoustic stress [noise level] do not affect the level of blood pressure if exposure [years employed] and schedule are kept constant. If different exposure lengths and schedules are introduced, workers with a longer exposure do have a higher blood pressure, and workers with a two or more shifts schedule do have a lower average blood pressure." [findings not consistent across ages]..."Our results seem to suggest that it may be next to impossible to evaluate the particular factors in isolation, and that results should always be seen as the outcome of the working and living environment as a whole. The difference between the two age groups can be explained by the effects of age itself or by the different time factors, combined with other particular causes."

Overall Evaluation:

The strength of this study is its potential for considering multiple confounders such as weight, smoking, diet, etc. Unfortunately, only age was treated as a possible confounder and was poorly controlled by the use of only two age groups. Further analysis in a multivariate mode would be informative. It would be particularly useful to know if workers with a longer exposure within each of the noise level groups showed higher blood pressure when age was controlled at the individual level.

(Scores on a scale of 0-9)

Noise Exposure = 5
Health Effects = 7
Epidemiologic Method = 3

Citation: Geller, L.I., Sakaeva, S.Z., Musina, S.S., Kogan, IA.D., Belomytseva, L.A., Ostrovskaia, R.S., Volokhov, IA.P., Luk'ianova, E.S., Popova, R.M. and Moskatel'nikova, E.V.: The Influence of Noise on Arterial Blood Pressure. Terapevticheskii Arkhiv 35(7):83-86, 1963. (Russian)

Researchers and Institution where research performed:
Clinic of the Ufimsk Scientific Research Institute of Hygiene and Occupational Diseases, Russia.

Stated Purpose: To study the etiology of hypertension since probable etiological factors such as the effect of persistent noise deserve further attention.

Study Design and Sample:
: Workers in oil industry; no differences of men and women in any group.
: Cross-sectional with 1482 workers in oil gases, 366 in oil gases and high noise or primarily high noise compared to 263 in administrative work and 456 in physical work at the factory.
: No indication as to how sample was selected, nor of completeness of sample or participation rate by the various worker groups.

Data Sources : Not stated.

Bias Potential in Design:
Selection and selective survival. Appears unusual that there were no differences in the relation of men and women in any group including physical work.

Noise Exposure:
Noise Description:
Source : Gas and air compressors, pump, turbo-gas blowers and "some other facilities of oil mining and processing."
Type : Oil industry noise; not reported as to steady or unsteady.
Frequency Composition: High frequency (2400-6000Hz).
Levels : 115 to 125 dB.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not specified.
Environment : Uncontrolled; industrial; relative positions of source to subjects not reported.
Subjects : No evidence of history of noise exposure on the job given; hearing thresholds, avocational exposures and ear disease not reported.
Evaluation : Noise parameters not reported in sufficient detail to know the individual subjects nor work area exposure to noise.

Health Effects:
CVS Response : Hypotension defined in a table as $\leq$ 99 maximal arterial pressure or $\leq$ 69 minimal arterial pressure. Evident

and doubtful hypertension not defined. Cardiovascular neurosis was not defined.

Evaluation : No diagnostic criteria or measurement procedures described for any of the three measures. Quality control of the data is questionable. History and treatment for hypertension and co-morbidities unknown.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively.

Statistical Methods: Findings said to be statistically significant. No specific tests shown with the data.

Dose-Response : Noise data insufficient to detect.

Temporal Relationship: Not clear in cross-sectional data. Findings were consistent with other investigators quoted by authors.

Control for Potential Confounders:

Sex and age were controlled by stratification - only two age groupings used, under age 40 and over age of 40. Statistical controlling for age and sex would have been desirable. No data on additional characteristics of subjects such as obesity, social class.

Conclusions:

Authors : "In persons exposed to the effect of persistent high noise, arterial hypotension is less common and hypertension much more common than in workers whose work conditions are not connected with the influence of noise. Cardiovascular neurosis is found in workers exposed to the effect of noise in a higher number of cases than in employees performing other physical or administrative duties."

Overall Evaluation:

This cross-sectional study may suffer from exposure suspicion bias since no data on selection and exclusion of workers are provided. Its major weakness is the inadequate information provided on both noise exposure and health outcome, hypertension and hypotension.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 4
Epidemiologic Method = 2

Citation: Gel'tishcheva, E.A.: Dynamics of the State of the Cardiovascular System in Adolescents During Performance of Delicate Visual Work Involving Industrial Noise. Gigiena Truda i Professional'nye Zabolevaniia (1):25-29, January, 1980. (Russian)

Researchers and Institution where research performed:
F.F. Erisman Hygiene-Institute, Moscow.

Stated Purpose: To study the dynamics (during one day, one week, one year) of the functional state of the cardiovascular system in adolescents performing delicate visual work involving industrial noise (the assembly of men's wrist watches).

Study Design and Sample:

: Occupational group in a watch assembly plant and students undergoing industrial training in assembly shops.

: Subjects assessed on cardiovascular indicators during the course of one day and one week and at the end of one year; workers and students exposed to similar noise conditions (not higher than PS 70).

: 36 adolescents aged 16-18 years observed under industrial work conditions were compared to a control of 11 students, aged 16-17, undergoing industrial training in assembly shops and working at their own rhythm and tempo with no production quota.

: Subjects said to be healthy and of average physical fitness; there were no differences in the studied indicators of the cardiovascular system by area, age, length of employment (1-3 years) or operations performed; there were no differences in the initial values of the cardiovascular indicators between adolescent workers and students of the vocational training schools.

: Sample selection and response rate of the subject pool are not provided.

Data Sources : Not described.

Bias Potential in Design:
Selection bias; bias due to changes in conditions of testing, changes in the work environment over the year studied and changes in avocational noise exposures of the observation period.

Noise Exposure:
Noise Description:
Source : Equipment types PPCh-6, PPCh-6M, P-90 which stamp the works of the watches.
Type : Industrial noise (the assembly of men's wrist watches); intermittent stamping noise.
Frequency Composition: Dominant in the range of the octaves with an average geometrical value of the frequencies 500-1000-2000 Hz
Level : Noise exceeded by 1-4 dB the maximum spectrum (MS)65, but was not higher than PS 70.

Duration of Exposure: Continuity of a work day was 82%; actual exposure to noise was not given.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; workshop; relative positions of noise sources and workers not described.

Subjects : Adolescent workers had history of 1-3 years of employment; no other information provided as to vocational noise exposure. History of avocational noise exposure, history of ear disease and hearing thresholds were not reported.

Evaluation : Noise exposures are questionable. Study is lacking in description of noise, instrumentation, measurement procedure. Subjects are described only as healthy adolescents of an average physical fitness. Student controls may not be comparable to adolescent workers on noise exposure. No exposure information provided for controls.

Health Effects:

CVS Response : State of the cardiovascular system evaluated through repeated examination of several indicators: frequency of the pulses, arterial pressure, systolic arterial pressure, diastolic arterial pressure, pulse pressure, systolic and minute blood volumes derived according to the formula of Liliestrand, and EKG test for hyperventilation. Pulse rate and arterial pressure measured directly at the work places. Vagotonic reaction discussed in the paper is not described. No information provided as to measurement procedures and quality control of the data.

Evaluation : The measurement procedures for blood pressure readings and the methodology of EKG recordings are unclear (controls and standards from the literature are not defined). The clinical significance of the EKG findings (if any) are unknown. The validity of the derived method for systolic and minute blood volumes is unknown - it appears to be derived from heart rate and pulse pressure.
There is no indication in the paper that workers and their student controls were comparable on position of head and body during work. Differences in work positions could explain change in blood pressure and systolic blood volume. Exercise would, by definition, reverse these effects.
In summary, the significance of the observed cardiovascular parameters to disease onset has not yet been established.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively.

Statistical Methods: Statistical significance stated, but no tests provided.

Control for Potential Confounders:

Subjects considered by author to be comparable on age, length of employment, operations performed and initial cardiovascular system indicators. It is difficult to determine specific confounding variables which need to be controlled since hypotheses are unclear. No evidence of any statistical controlling in the analysis.

Conclusions:

Author : "1. The intensive delicate visual work performed under exposure to occupational noise not exceeding MS 70 (75 decibels) shows an adverse effect on the functional state of the cardiovascular system in adolescents.

2. The changes of the functional state of the cardiovascular system in the process of occupational activity are more pronounced in the adolescent workers than in the students of VTS.

3. Occupational gymnastics promotes the improvement of the functional state of the cardiovascular system in adolescents."

Overall Evaluation:

The conclusion of the author that intensive work under exposure to occupational noise, not exceeding 75 dB, shows an adverse effect on the cardiovascular system in adolescents appears unwarranted. The observed changes over the course of the year (drop in systolic pressure, systolic blood volume, minute blood volume and rise in diastolic pressure; reduction in frequency of heart contractions and increase of the projections R and T of the EKG data) cannot be adequately assessed without an appropriate comparison group. Apparently both workers and student controls were exposed to the same or similar noise levels. The study also suffers from small sample size and poor specification of the noise and cardiovascular parameters.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 4
Epidemiologic Method = 1

Citation: Graff, Von Ch., Bockmuhl, F. and Tietze, V.: Noise Strain and Arteric (Essential) Hypertonic Sickness in Humans. In S. Nitschoff and G. Kriwizkaja (Eds.) Larmbelastung, Akustischer Reiz und Neurovegetative Storungen, Leipzig, 1968. (German)

Researchers and Institution where research performed:
Not stated.

Stated Purpose: To study the reaction of the central nervous system and therefore essential hypertension as a disturbed autonomic system control as a possible result of sound pressure.

Study Design and Sample:
: Occupational groups of workers in a boiler plant.
: Cross-sectional study.
: 117 workers exposed to 95-110 dBA noise consisting of locksmiths, blacksmiths, welders, tube-benders, transportation workers and crane drivers compared to 50 workers in heavy transportation in the same plant without noise strain.
: Both groups had the same age distribution, were men, and workers at a two shift system; men with history of hypertensive disease were excluded.
: No information provided on sample selection and response rate.

Data Sources : Not specifically stated, but from references it appears that data were collected for other purposes in 1966 by history and clinical exams.

Bias Potential in Design:
Selection bias (selective survival and healthy worker effect); measurement bias.

Noise Exposure:
Noise Description:
Source : Noises encountered by locksmiths, blacksmiths, welders, tube-benders, transportation workers and crane drivers; specific sources not identified.
Type : Boiler plant noise, impulse character.
Frequency Composition: Medium to high frequency.
Level : 95-110 dB(A) including a corrective number of + 5 dB(A) for the ordinary sound level.
Duration of Exposure: Years of working in environment with noise strain indicated by tabled entries; however, precise exposure times for subjects not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; boiler plant, not described.
Subjects : Only job related noise exposures at boiler plant considered. History of avocational noise exposures and history of ear disease not reported. Hearing thresholds obtained after noise exposure.

Evaluation : Noise parameter information is lacking in this study. Exact exposures of subjects to damaging noise levels were not given. Noise frequency and duration not reported, nor were noise sources, noise measurement procedure, environment regarding subjects and noise sources. No instrumentation utilized for measuring noise. Audiometric findings were examined among the group with pathological findings. It is unclear how the noise exposure of the heavy transportation workers serving as controls differed from the transportation workers in the noise-exposed group. No information was provided for noise levels experienced by the 50 workers without noise strain.

Health Effects:

CVS Response : Increase in blood pressure categorized into 4 grades:

I - SBP 150-180 mm Hg and/or DBP 95-100 mm Hg, no pathological conditions on physical exam.;
II - SBP 185-200 mm Hg and/or DBP 105=120 mm Hg with eye background changes I;
III - SBP > 200 mm Hg and/or DBP 125-130 mm Hg with congestive heart failure and eye changes II-III;
IV - SBP > 200 mm Hg and/or DBP > 135 mm Hg with congestive heart failure and eye background changes III-IV.

Blood pressure taken in the supine position.

: Standard EKG and EEG, skin galvanic reflex, blood count and sedimentation rate and numerous other parameters measured. No criteria for defining cardiovascular pathologies other than hypertension.

Evaluation : Exact methodology for determining blood pressure and quality control of the data not given. No diagnostic criteria or definitions provided for multiple cardiovascular parameters. Noise may be confounded by other factors such as danger on the job and results modified because of confounding. According to the authors, locksmiths and blacksmiths held the more dangerous jobs. It is not clear to what extent the 50 control workers were examined allowing appropriate comparisons of the data.

Judging Causal Significance:

Strength of the Association: Not quantified. Authors report that a majority of the hypertension subjects (42/117 = 35.9%) as well as subjects with other heart and circulation findings were among the noise exposed as compared to those without noise strain (no numbers presented, approximately 10-15% from graph). Comparisons by age, length of employment, job groups, degree of hypertension and audiometric findings among the illness groups of the 117 noise exposed workers only.

Statistical Methods: Data presented in graph form only. No statistical tests given.

Control for Potential Confounders:

No evidence of control for any potentially confounding variables in the comparisons between the noise exposed and workers without noise strain. It appeared that those with disease were older and had the longest exposure, suggesting confounding by these factors.

Conclusions:

Authors : A larger proportion of hypertensive patients and patients with other heart and blood circulation sickness were found among the noise exposed group than among the workers without noise strain.

Within the noise-exposed group, 25-35 year olds, locksmiths and blacksmiths and individuals exposed at least 8 years were most likely to present with hypertension and other circulatory problems.

"In the patients with other heart and blood circulation disorders and in the group without pathological findings, low grade, medium and high grade hard-hearing persons were found, but the number of normal hearing persons was lowest in the group of persons with high blood pressure."

Overall Evaluation:

There is evidence of two major problems in these cross-sectional data: (1) selective survival and attrition from the work force among older workers in the noise exposed group; (2) inappropriate analysis with failure to make comparisons between the noise exposed and non-noise groups and failure to control for confounding factors. This study provides weak, if any, support for an association between noise exposure and cardiovascular disease.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 4
Epidemiologic Method = 4

Citation: Grusha, A.N.: Arterial Pressure in Patients with Neurosis-Like State. Vrachnbnoe Delo 4(11):48-50, 1974. (Russian)

Researchers and Institution where research performed:
Neurological Ward of the Chernikhov Regional Hospital, Russia.

Stated Purpose: To study neurosis-like states which developed following closed cranio-cerebral injuries (100 patients), infectious arachnoencephalitis (110 patients), and as a result of a long-term effect of high frequency industrial noise (134 patients).

Study Design and Sample:
: Cross-sectional patient series.
: Comparison of 100 patients with closed cranio-cerebral injuries, 110 with infectious arachnoencephalitis and 134 patients with neurosis-like states as a result of a long-term effect of high frequency industrial noise and 26 controls.
: No data as to sampling frame, means of patient selection or time interval of the study.

Data Sources : Not stated; apparently from records on Neurological Ward of the Chernikhov Regional Hospital.

Bias Potential in Design:
Sampling and selection bias very probable; very small control group.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : High-frequency industrial noise; not specified as to steady or unsteady.
Frequency Composition: Not reported.
Levels : Not reported.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Apparently uncontrolled.
Subjects : No specific data provided. No criteria or information indicating how patients were diagnosed with neurosis-like states "as a result of long-term effect of high frequency industrial noise."
Evaluation : Author provides no information on which to assess noise exposure.

Health Effects:
CVS Response : Brachial arterial pressure measured by Korotkov-IAnovskii method; temporal pressure by the Markelov method; central retinal arterial pressure (CRA) by the Baiiar method.
Evaluation : No information provided as to diagnostic or definitional criteria, measurement and quality control of the data.

Marked variation in frequency of hypertension and hypotension between methods. Relationship of times of different measurements not stated.

Judging Causal Significance:

Strength of the Association: None reported.

Statistical Methods: None reported. Although a control group of 26 was shown in one table, its use in the analysis is very unclear.

Control for Potential Confounders:

No evidence of any controlling in design or analysis. Age was not given. Sample consisted of 258 females and 86 males; no data as to sex distribution in the groups and no evidence of adjustment for unequal distributions.

Conclusions:

Author : "The data presented show that brachial arterial pressure was most stable in patients with neurosis-like states following the effect of intensive high-frequency long-term industrial noise and infectious arachnoencephalitis." Of patients with neurosis-like states from long-term effects of industrial noise, a greater proportion (27.6%) suffered from temporal arterial hypertension than from brachial arterial hypertension (3.0%). "The elevated arterial pressure in CRA due to the effect of high-frequency industrial noise is less pronounced [than the other disease groups]."

Overall Evaluation:

Although frequently referenced in reports of the adverse effects of noise, this study is of questionable etiologic relevance because of its failure to state how illness due to noise was determined, the lack of specific data as to blood pressure measurement, the apparent failure to use a control group, the potential bias in using a convenient group of patients and failure to control for potential confounders.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 1
Epidemiologic Method = NA

Citation: Ising, H., Gunther, T., Havestadt, C., Krause, Ch., Markert, B., Melchert, H.U., Schoknecht, G., Thefeld, W. and Tietze, K.W.: Study on the Quantification of Risk for the Heart and Circulatory System Associated with Noise Workers. EPA translation TR-79-0857, Office of Noise Abatement and Control, 1979. (German)

Researchers and Institution where research performed:

Ising, Krause and Markert - Institute for Water, Soil and Air Hygiene of the BGA, Berlin;

Gunther - Institute for Molecular Biology and Biochemistry, Free University, Berlin;

Havestadt - Industrial Physician's Center of the Berlin Society, e.V.;

Melchert, Schoknecht, Thefeld and Tietze - Institute for Social Medicine and Epidemiology of the BGA, Berlin.

Stated Purpose: "...To demonstrate the methods which can be used to prove noise effects relevant to the health with statistical significance. In addition, this study should provide initial proof that the risk for the heart and circulatory system is increased by noise stress. The importance of magnesium in noise sensitivity...is also to be tested."

Study Design and Sample:

: Occupational groups: workers at 3 divisions of the Dortmunder Union Schultheis Brewery.

: Cross-sectional and interventional investigation (with and without hearing protectors).

: 100 workers invited to participate; 90 volunteered.

: 36 subjects employed in noise area of plant and 54 in areas of less noise. 10 subjects excluded from control group in order to standardize the age distribution. Out of the 80 workers, 30 exposed to noise and 16 controls were examined during work. The control workers were studied for one day, whereas 18 of the workers exposed to noise were examined for 2 days and 12 of them for 2 weeks. For the latter group, half of the time the subjects wore hearing protectors and the other half of the time they worked without hearing protectors. Other subgroups of the subjects studied. It is unclear from the data whether or not the total 80 volunteers were studied and if so, in what specific comparisons.

: No information provided as to how the 100 subjects were originally selected nor the specific criteria used in excluding 10 volunteers.

: All noise workers and controls carried noise dosimeters during the investigation. The mean noise level and standard error for the noise exposed workers was 95 ± 0.7 dB(A) and for the controls was 82 ± 1.2 dB(A).

Data Sources : Primary data collection for study purposes.

Bias Potential in Design:
Selection; possible Type II error due to small sample size especially for detecting differences in blood pressure.

Noise Exposure:
Noise Description:

Source : Bottles impacting, bottle washing equipment, bottle illumination equipment, transporting belts and machinery, and CO_2 gas emitted under pressure.

Type : Industrial; steady and nonsteady (peaks).

Frequency Composition: Third octave analysis: bottle washing 63 to 6300 Hz and 400-6300 Hz; illumination: 800-2500 Hz with one isolated peak at 5000 Hz; filling installation: 315 to 5000 Hz with resonant excess at 4000 Hz; bottle labeler: 3150 to 5000 Hz with slight maxima at 1000-1250 Hz.

Levels : Bottle washing: basic noise level 90 dB(A) with peaks of 102-106 dB(A); filling installation: 3 dB increase per octave above basic level with slight resonance excess at 4000 Hz and dense level peaks of approximately 2 dB; illumination: frequent peak levels of 5-15 dB(A) above basic level; bottle labeler: frequent level peaks of 5-10 dB(A) above basic level with slight maxima.

: For workers while wearing dosimeters: bottling cellar workers - mean values of 95 dB(A) ± 0.7 dB and control group - mean value of 82 dB(A) ± 1.2 dB.

Duration of Exposure: Not reported; constant exposure to basic noise level during working hours is presumed, but exposure was probably variable because they did not remain at one fixed work site.

Instrumentation: Precision sound level meters, B & K 2206, AM tape machine (Naga), actual third-octave analyzer HP8054A, level recorders B & K 2305, acoustic calibrator (B & K), noise dose measurement by Dosimeter, Genrath 1954 and 9740; compliance with standards.

Measurement Procedure: Locations of measuring microphones relative to noise sources not reported; tape recordings of the working noise were made at 4 typical work sites in the bottling cellar, then evaluated in the laboratory. Third octave analysis. Dosimeters worn on upper body of the subjects. Compliance with standards not reported.

Environment : Six environments studied; description of workers' relationship to noise sources not specified; uncontrolled work environments and controlled conditions studied. Dosimeters are one means of "controlling" noise environment.

Subjects : History of vocational noise exposure not reported; one attempt was made to look at avocational exposures during the "free-time examination" of the study. Hearing thresholds reported, but no information provided on history of ear disease and otological examination.

Evaluation : Good study relative to identifying noise parameters and instrumentation used for measuring noise. However, expansion of information on the noise environments, noise measurement procedure and subject characteristics is needed.

Health Effects:

CVS Response : Blood pressure measured at the end of the shift, carried out under same noise conditions under which subjects worked, with individuals in sitting position. Semi-automatic measuring device used with a mean value from a minimum of four individual measures taken as the measured value.

: Blood and urine values included epinephrine, norepinephrine, glucose, total protein, potassium, cholesterol, magnesium and other parameters.

: In addition to CVS response variables, hearing thresholds, age, height, weight were assessed.

: No evidence that examiners, especially for blood pressure readings, were unaware of noise status.

Evaluation : Although most of the parameters studied do not require diagnostic criteria it is not clear how disturbances in metabolism, increase in cholesterol and prediabetic states were determined. Diastolic blood pressure phase was not specified. The meaning of a difference in total protein is of unknown clinical significance mainly because total protein is a reflection of general nutrition. There was no evidence of exclusions or controlling for coexisting disease. Duration of employment in noise is not stated. Body build and weight not adequately controlled. Differences in body build might account for some of the observed differences in creatinine excretion between the noise exposed and control groups.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively. Although there were no significant differences in systolic and diastolic blood pressure between the noise exposed and control group, the difference observed was suggestive of a noise effect.

Statistical Methods: t-test for difference in means.

Control for Potential Confounders:

Although the groups were shown not to be different on age and weight, statistical controlling for age, sex, smoking, body build should have been included.

Conclusions:

Authors : "When working without ear defenders at a mean exposure to noise of 95 dB(A), the systolic blood pressure was higher by almost 7 mm Hg ($\alpha < 0.001$) and the excretion of vanillyl mandelic acid in urine was higher by 67% ($\alpha = 0.013$) and that of noradrenaline by 16% ($\alpha = 0.05$) than when working with ear defenders. The actual daily average noise level reduction of this device was 13 dB. After one week of work without ear defenders magnesium concentration in the blood of 12 test persons was by 5% ($\alpha = 0.05$) lower than after one week of work with ear defenders. The evaluation of the parameters of 26 test persons showed a negative correlation of $c = -0.52$ ($\alpha = 0.003$) between the magnesium content of blood sediment and the increase in blood pressure when exposed to noise."..."The comparison of noise workers and a control worker group, however, indicated no (statistically) significant difference."..."Only the examination of the same test subject under two or more different noise stress conditions is suitable for proving the effects of noise with statistical significance."

Overall Evaluation:

This pilot study was judged to be quite useful in suggesting methods that can be utilized in the study of the health effects of noise. Noise and health parameters were specified in detail. However, the sample size is small and the nonsignificant blood pressure differences may be related to Type II error. The data were inadequately adjusted for age, sex, weight, and smoking.

(Scores on a scale of 0-9)

Noise Exposure = 6
Health Effects = 4
Epidemiologic Method = 6

Citation: Jansen, G.: The Occurrence of Vegetative Functional Disturbances Resulting from the Influence of Noise. Archiv fur Gewerbepathologie und Gewerbehygiene 17:238-261, 1959a. (German)

Researchers and Institution where research performed:
The Max-Planck Institute for Occupational Physiology, Dortmund.

Stated Purpose: To determine if there are pathological changes which definitely are produced by noise influences.

Study Design and Sample:

: Occupational groups working in 15 metallurgical plants in Germany, 1956-1958; plants selected to be representative of all the factories.
: Cross-sectional study with data collected by interview and examination.
: 1005 workers selected to be representative (method unclear) with consideration given to the noisier sections of the plants.
: 669 were assigned to group with strong noise influence and 336 to group with low noise influence.
: workers were of average age 42 years with average for employees in noisy industries of 42.9 and in low noise areas an average of 41.4; average length of employment for noise exposed workers was 11.1 and average for low noise workers was 11.4 years.
: Response rate said to be high since employees lost no pay by participating; refusals to participate in selected aspects of the study were low except for social-psychological questions.
: Sample selection methods not described fully.
: High and low noise group differed in occupations.

Data Sources : Interviews and physical and laboratory examinations for study purposes.

Bias Potential in Design:

Selection especially healthy worker effect; author notes that prior to their employment the employees exposed to high noise levels were healthier than the low noise group. Exposure suspicion bias likely since health measurements were taken in plant medical offices after noise determination level and began with "talk about the shop, the kind of work, and the working time" to help "overcome embarrassment of the workers." Selective recall bias: symptoms may have been recalled at a higher frequency among high noise group than among low. Measurement bias may be present; each investigator used a predetermined questionnaire, but flexibility was permitted in its use depending upon the situation or need. In addition, the extent to which subjects in the high noise area as opposed to the low refused to answer specific questions was not reported.

Noise Exposure:

Noise Description:

Source : Not reported; 34 occupations listed, but noise sources not reported.

Type : Industrial (smelting); steady or nonsteady not reported.

Frequency Composition: "A troublesome noise measurement was made" (referenced to Laird and Coye). Although it was stated that it was possible to determine if high frequencies or low frequencies were predominating, the information was not reported.

Levels : Actual levels not reported. High noise group: ranges III and IV (of Lehmann) appears to be approximately > 90 dB as plotted by phons in Figure 1.
Quiet group: ranges I and II (of Lehmann) appears to be < 90 dB as plotted in Figure 1.

Duration of Exposure: Not reported; average years of employment 11.1 for high noise and 11.4 for low noise group.

Instrumentation: "Noise measuring appliance"; not reported whether sound level meter, oscilloscope, etc. Type EZL (by Rohde and Schwarz) with 60 to 120 dB range.

Measurement Procedure: Not reported.

Environment : Uncontrolled; metallurgical plants; source to subject relationship not described.

Subjects : Worked at least 3 years under same conditions. No other work exposures noted. History of avocational exposures, history of ear disease and hearing thresholds not reported.

Evaluation : Poor study regarding noise parameters. Lists number of workers by occupations (34 different types) and then categorizes according to numbers exposed to strong noise versus those exposed to low noise. Frequency, intensity and durations described in a general way. Noise sources and noise environments not described.

Health Effects:

CVS Response : Symptoms of vascular and cardiac problems.
: Tachycardia, irregular cardiac activities and extrasystoles and blood pressure on medical examination.
: Blood measures.
: No information provided on measurement procedures or diagnostic criteria.

Evaluation : No diagnostic criteria given and no evidence of standards used in the routine physical examinations presumed to be conducted by the 15 plant physicians. Although there was a definition provided for "objective observations", no statement was given as to how these were quantified or controlled. In Table 2, the findings labeled "objective" do, in fact, require subjective judgments of the examiner. Criteria of abnormalities described such as "facial expression" were not given. Blood tests were not taken from people who appeared anxious. As the author indicates, some of the findings such as change in circulation in the hands may be related to high vibration rather than noise. The discussion on mechanisms was based on a poor understanding of cardiovascular physiology as we know it today.

Judging Causal Significance:
Strength of the Association: Not stated.
Statistical Methods: Chi-square.

Control for Potential Confounders:

High and low noise groups described in great detail as to personal, environmental, working conditions, economic status, living conditions and family life. However, there is no evidence of controlling for any potentially confounding variables.

Conclusions:

Author : "Vascular disturbances in the extremities, skin findings (paleness) and cardiac findings (rhythm disturbances, tachycardia, extrasystoles) occur statistically significantly more frequently in subjects exposed to high noise levels."..."Thus, all this would prove that vascular disturbances, skin findings, and cardiac findings as indicated in workers exposed to noise are caused by noise and thus could be designated as 'noise determined' symptoms or findings. The proof can be based on previous results of experimental noise research."..."In conclusion it should be mentioned that this report merely included a comparison between workers under high noise levels and those under the effect of low noise levels. It is probable that a comparison of subjects exposed to low noise levels and those exposed to no noise (noise range 0) would also reveal characteristic differences."

Overall Evaluation:

A large cross-sectional study which attempts to select workers representative of the metallurgical plants in high and low noise exposures. Data were collected on a large number of potentially confounding variables and extensive interviews, medical examinations and blood evaluations were conducted. However, the reviewers cannot agree with the author's strong conclusion of a relationship between noise and vascular and cardiac disturbances. Inferences are difficult because the noise and cardiovascular measures were poorly described and documented by the data; the healthy worker effect, exposure suspicion bias and potential measurement bias probably influenced the findings; and there was no evidence of statistically controlling for confounding factors.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 2
Epidemiologic Method = 3

Citation: Jansen, G.: Noise Stress in the Smelting Industry. Stahl und Eisen 81(4):217-220, 1961b. (German)

Researchers and Institution where research performed:
Max Planck Institute for Occupational Physiology in Dortmund.

Stated Purpose: Because ear damage is not the only form in which noises can affect the human organism, examinations of a series of vegetative functions of the human organism with respect to noise were conducted.

Study Design and Sample:

: Occupational groups from the smelting industry previously described in a 1959 paper.

: 669 workers exposed to noise of more than 60 dB(B) and 339 workers from companies where the sound level was not less than 65 dB(B).

: Subjects were from 20-60 years of age with an average age of 42; employed at same work place for at least 3 years; average length of employment of 11 years; were not involved with disability pensions or suffering with chronic diseases; the two groups contained the same shift ratios.

: No information provided regarding sample selection and response rate in this paper.

Data Sources : Not stated specifically; see summary of 1959 paper.

Bias Potential in Design:
Selection and measurement bias. See summary of 1959 paper.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Industrial (smelting); steady or nonsteady not reported.
Frequency Composition: Not stated.
Levels : High noise group = more than 90 dB(B)
Low noise group = noise not less than 65 dB(B), presumed 60-90 dB(B).
Duration of Exposure: Not stated; average length of employment was 11 years.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled.
Subjects : Employed at the same work place for at least 3 years. Other work exposures not reported. No information provided on history of avocational noise exposure, hearing thresholds nor history of ear disease.
Evaluation : Work related noise exposures were poorly presented. (Series of laboratory studies described in paper were not critiqued.) Instrumentation, measuring procedures, subject information and noise description were not reported.

Health Effects:

CVS Response : Symptoms of vascular and cardiac problems.
: Tachycardia, rhythm abnormalities and extrasystoles.
: No information provided on measurement procedures or diagnostic criteria.

Evaluation : Methodology and diagnostic criteria not stated. Findings reported as "objective" required subjective judgments of the examiner. When the medical and psychological examinations of the subject were negative, noise was considered the probable cause of the vegetative functional disturbances. It should be noted that the total result of the examinations reportedly showed no defined noise disease with the exception of hearing damage. Author's conclusions apparently are based on subjective sign and symptom data.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Not given; results reported as statistically significant.

Control for Potential Confounders:

No evidence of controlling for any variables such as age, sex, social class.

Conclusions:

Author : "The total result of the examination showed that no defined noise disease could be determined, with the exception of hearing damage."..."The vegetative disturbance is stronger than had been suspected; it occurs expecially with wideband noises and can be detected in persons at rest and engaged in physical activity. A comparative examination of 1005 persons employed in the smelting industry confirmed these findings."

Overall Evaluation:

This cross-sectional study utilizing very subjective data contributes little to the assessment of the effects of noise on the cardiovascular system. It apparently is a second report of an earlier study. See summary of 1959 paper.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 1
Epidemiologic Method = 2

Citation: Jirkova, H. and Kremarova, B.: Investigations of the Effect of Noise on the General Health of Workers in Large Engineering Factories: An Attempt to Evaluate. Pracovni Lekarstvi 22(4): 147-148, 1965. (Czechoslovakian)

Researchers and Institution where research performed:
Not stated.

Stated Purpose: To determine whether in noisy workplaces there is a higher occurrence of illnesses which, in accordance with current knowledge, might have a causal relation with noise.

Study Design and Sample:

: Cross-sectional study of workers from 34 noisy workplaces and 6 not-noisy places.

: 766 men and 203 women from noisy workplaces and 371 men and 318 women from not-noisy workplaces were compared as to chronic illnesses reported by the plant physician and absences from work due to illness. Noisy workplaces had noise levels ranging between 85-115 dB for the greater part of the day which were considered dusturbing because its intensity exceeded the amount necessary for conveying information; quiet areas had a noise level lower than 70 dB and was not disturbing. Workers were classified as younger than or older than 40 years of age and by length of employment (up to 10 years and more than 10 years).

: Sampling frame, sample selection and response rate were not described.

Data Sources : Records in the documents of the plant physicians.

Bias Potential in Design:
Selection bias possible; as noted by the researchers, a shortcoming was the variable quality of the data in records from examinations by various doctors who used no standardized methods; the extent of unreported illness is not known.

Noise Exposure:
Noise Description:

Source : Specific sources not identified; noisy workplaces included motor testing sections, compressor stations, machine-rooms, etc.

Type : Industrial (in large engineering factories) presumed steady because noise existed continually for the greater part of the working day.

Frequency Composition: Spectral characteristics of noise were measured; however, authors only report that "results at all workplaces showed a significant predominance of tones of a frequency ca. 1000c/sec."

Levels : Noisy: 85-115 dB; not-noisy: <70 dB.

Duration of Exposure: Not reported precisely; subjects divided into two groups: exposed to noise for less than 10 years or exposed to noise for more than 2 years.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Not described; uncontrolled.

Subjects : Workers classified on basis of exposure to noise for more than or less than 10 years; no avocational exposures given; no evidence of history of ear disease. Although "hearing damage (without closer determination of the type and cause)" was investigated, there is no indication that hearing was tested.

Evaluation : The study is poor regarding noise parameters. Noise sources and frequency composition are lacking. Noisy workplaces are described with a very wide variation in noise level, 85-115 dB, without indication of tendency toward higher or the lower levels. Noise environments of the 34 workplaces were not described and instrumentation and measurement data were not reported.

Health Effects:

CVS Response : Hypertension, and hearing damage determined from medical records and general absences from work due to illness. Other health problems studied were peptic ulcers, neurosis, subjective complaints and other chronic illnesses.

Evaluation : No information given as to definition of hypertension, criteria for diagnosis, methods used in collection of data. Authors indicate poor quality control in terms of reliability and validity of the measures as recorded by the plant physician. Time period covered by the study is not stated.

Judging Causal Significance:

Strength of the Association: Not stated.

Dose-Response Relationship: For men younger than 40 years, the cases of absences from work due to illness were lowest in men of the control group and highest in men exposed to noise for more than 10 years. The statistics quoted are not adequate for evaluating a dose-response effect. Statistically significant differences were noted between exposed and controls.

Statistical Methods: Chi-square employed in statistical evaluation.

Control for Potential Confounders:

Although the authors report that it was possible to eliminate the effect of other factors such as toxic substances, excessive psychic loads and that the characters of the work compared were similar, it is questionable as to whether or not this was accomplished with 34 noisy and 6 not-noisy workplaces. Age was partially controlled. All other variables were examined only in the univariate sense.

Conclusions:

Authors : "The results of the comparison show a higher occurrence of hearing damage, subjective complaints, hypertension, and peptic ulceration in persons exposed to noise." On the other hand, the authors did not show that the frequency of the diseases investigated, with the exception of hearing damage, depended on the length of employment. Findings were not consistent for men and women.

Overall Evaluation:

Although the data are suggestive of a positive association between reported hypertension and noise level, the differences observed were not statistically significant. Age was only partially controlled; social class indicated by skill level and other potential confounders were not statistically controlled. The noise parameter, health outcome and methodology employed were not reported in detail.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 1
Epidemiologic Method = 3

Citation: Kachnyi, G.G.: Indices of Arterial Pressure in Female Weavers Under Conditions of Industrial Noise. Vrachebnoe Delo (4):107-109, April 1977. (Russian)

Researchers and Institution where research performed:
Medical-Sanitary Department of the Worsted Cloth Combine in Chernigor.

Stated Purpose: Study of the state of the vascular tone of the brachial and temporal arteries during work time in relation to the length of industrial employment of female weavers exposed to the effect of industrial noise of varying intensities.

Study Design and Sample:
: Female weavers 15-27 years of age working at the Chernigovskii Worsted Cloth Combine Plant.
: Cross-sectional comparison of 300 weavers working in noise of 106-108 dB (Group 1) to 291 weavers working in an intensity of 102 dB (Group 2). Weavers of Group 1 served 2-3 looms; Group 2 served 6-8 looms. All subjects were women who previously were not subject to the effects of an industrial environment, but had worked 1-2 years in an office or on a collective farm. Twenty healthy girls of similar age working in the plant administration served as controls.

Data Sources : Not stated, apparently existing industry data.

Bias Potential in Design:
Selection and non-response bias. Comparability of noise exposed and control groups is questionable.

Noise Exposure:
Noise Description:
Source : Group 1: shuttle looms of the TSFS type, "Peak & Peak".
Group 2: micro-shuttle looms of the STB type.
Type : Industrial noise in textile mill; varying intensities implies nonsteady noises.
Frequency Composition: Too general to be useful.
Group 1: a high frequency character of noise with complex spectra.
Group 2: analogous to Group 1 noise.
Levels : Group 1: 106-108 dB; Group 2: 102 dB.
Duration of Exposure: Exposure presumed on the basis of length of employment as follows:
Group 1: 17 employed for 3-6 months;
172 employed for 1-5 years;
111 employed for 6-10 years.
Group 2: 18 employed for 3-6 months;
164 employed for 1-5 years;
109 employed for 6-10 years.
Instrumentation: Not reported.
Measurement Procedure: Not reported.

Citation: Kalicinski, A., Straczkowski, W., Nowak, W., Proniewska, W. and Ro'zan'ska, T.: Cardiovascular Changes in Workers Exposed to Noise. Wiadomosci Lekarskie 28(1);1-4, 1975. (Polish)

Researchers and Institution where research performed:
Institute for Internal Medicine, Bialystok, Poland.

Stated Purpose: Not explicitly stated; implied to study changes in the central nervous system and in the cardiovascular system caused by noise.

Study Design and Sample:

: Occupational groups of spinners and weavers.

: Cross-sectional comparison using years of work in noise to characterize noise.

: Group I - from 1-6 years work in noise (31 women);
Group II - from 7-12 years work in noise (48 women);
Group III - 13 or more years of work in noise (61 women);
140 women ranging in age from 47-51 with average age 49 (±1.1 years).

: No data as to population at risk, sampling frame, response rate or methods whereby the women were selected.

Data Sources : Uniform questionnaire containing 57 questions with emphasis on symptoms characteristic of arterial hypertension and coronary diseases and primary BP and EKG measurements.

Bias Potential in Design:

: Selection, selective survival, selective recall, exposure suspicion bias.

: Years of work in noise may not accurately reflect levels of exposure.

Noise Exposure:

Noise Description:

Source : Spinning and weaving equipment presumed; type of equipment not identified.

Type : Spinning and weaving industrial noise; steady.

Frequency Composition: 32 Hz to 16,000 Hz.

Levels : 95-105 dB.

Duration of Exposure: Described above by groups.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; relationships of subjects to sources were not reported.

Subjects : The possibility of other vocational noise exposures was not explored; history of avocational exposures and ear disease not reported; no evidence that hearing thresholds were obtained on subjects at any time.

Evaluation : Although some noise parameters were identified, the accuracy of the measurements is questionable. It would be unusual for all frequencies between 32 and 16,000 Hz to have intensities falling between 95 and 105 dB. Failure to report value of the temporal-brachial coefficient from the norm were not observed.

Overall Evaluation:

The strength of this study is in the selection of subjects with no industrial noise exposure other than that under investigation. Unfortunately the data are poor for judging the association between noise and blood pressure because the control group apparently was not used and the noise levels for the two groups were high and similar; there was no evidence of controlling for potential confounders such as family history, obesity, stress and age; analytical techniques were limited. In general, it appeared that the researcher was unaware of current concepts of blood pressure and its measurement.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 6
Epidemiologic Method = 2

noise measuring instrumentation and procedures, or environmental relationships and subject information further weakened this study.

Health Effects:

CVS Response : Blood pressure taken after interview and 30 minutes rest; hypertension defined as > 140 mm Hg. systolic and > 90 mm Hg. diastolic. BP method not stated.

: EKG with 12 standard leads used to define:
(a) inadequate blood supply to heart - a drop in the S-T segment of more than 0.1 mV in the from the left chamber, with no signs of chamber hypertrophy;
(b) tendency toward inadequate blood supply of heart muscles - a drop in S-T less than 0.1 mV.

: Questions on 57 symptoms related to arterial hypertension and coronary disease.

Evaluation : Changes in S-T more often in HBP group - this may represent changes due to HBP (hypertension) and not independent "inadequate blood supply". A full description of S-T segment configuration was not provided and, therefore, the abnormality noted may have been a nonspecific change.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively; the percentage of persons with hypertension was 26% in women working 1-6 years in noise, 38% in those working 7-12 years and 47% in those working 13 or more years in noise, suggesting a dose-response relationship.

Statistical Methods: Chi-square.

Control for Potential Confounders:

Sex controlled by sample selection of women. Mean ages of the groups were similar. No evidence of controlling for weight, physical activity, cigarette smoking, family history or diet.

Conclusions:

Authors : The frequency of hypertension is significantly greater, the longer the occupational exposure to noise. There were no significant differences between subject groups as to "tendency toward inadequate blood supply" in the EKG nor were pain complaints associated with these changes. Drop of the S-T section greater than 0.2 mV was significantly more frequent in Group II than in Group I (but no differences between Groups II and III) with complaints typical of coronary disease accompanying the changes. The frequency of coronary disease in women with hypertension was 6 times greater than in persons with normal blood pressure. "The studies show that many years of work under noise significantly affect the frequency of the occurrence of arterial hypertension and symptoms of inadequate blood supply of the heart muscles in the EKG. The frequency of these disturbances is greater the longer the occupational exposure to noise."

Overall Evaluation:

This study has the elements of a good investigation, but could have been upgraded by additional information and improvement in the statistical analysis. The observations that Group I showed symptoms of inadequate blood supply to the heart muscles more frequently than Group II but not Group III with the longest exposure and the highest frequency of hypertension, and the fact that coronary disease was 6 times more frequent in hypertensives than women with normal blood pressure suggests that women with many years of work who were sick may have retired, died or dropped out for disability at a greater rate than women with fewer years of exposure. Little information is provided regarding the sampling, measurement of exposure and outcome variables and statistical analysis.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 4
Epidemiologic Method = 3

Citation: Kanevskaia, Zh. S., Maksimova, L.I., Kublanova, P.S., Shevyreva, N.A., Sineva, E.L. and Markova, T.F.: The Influence of Pulsed and Stable Noise on the Central Nervous System of Operators. Gigiana Truda i Professional'nye Zabolevaniya 1:22-25, 1977. (Russian)

Researchers and Institution where research performed:
F.F. Erisman Hygiene Institute.

Stated Purpose: To study the characteristics of the action of pulsed and stable noise on the central nervous system, with the intention to compile the material necessary for the formulation of corrections to the noise standards in the working areas of industrial sites.

Study Design and Sample:

: Occupational groups - 1. fitters, turners, framers with 39% of the workers women; 2. turret lathe operators, automat operators, straighteners, guillotine operators, pressers with 35% of the workers women. The two groups were almost equivalent in age = 25-45 years; 60% with length of employment above ten years. 3. Control group performed work similar to the work in the group examined (fitters, loaders and regulators), but not exposed to the effect of noise exceeding the Maximum Permissible Level.

: Cross-sectional comparisons among the three groups.

: Group 1 consisted of 256 workers exposed to wide-band stable noise with dominant high frequencies at level of 90-100 dBA, equivalent noise level = 95 dBA.

: Group 2 were 284 workers exposed to pulsed noise at level of 107-117 dBA against background of continuous noise of 90-100 dBA; equivalent noise level = 95 dBA.

: Control group consisted of 100 workers.

: No information provided as to sample selection, response rate.

: Authors report no vibration in the working places.

Data Sources : Not stated.

Bias Potential in Design:
Selection and measurement bias possible.

Noise Exposure:
Noise Description:
Source : Not reported, other than occupations as described under design.
Type : Industrial noise; stable or steady to pulsed or nonsteady.
Frequency Composition: Group 1 with "stable" exposure - wide-band with dominant high frequencies; Group 2 with "pulsed" exposure - wide-band and pulsed noise; Group 3, control group - not reported.
Levels : Group 1 = 90-100 dBA; Group 2 = 107-117 dBA and sometimes 122-125 dBA; equivalent noise levels for both groups reported as 95 dBA.

Duration of Exposure: Not reported, but 60% of workers in Groups 1 and 2 had been employed ten years or more.

Instrumentation: Not reported.

Measurement Procedures: Not reported.

Environment : Uncontrolled; not described.

Subjects : Additional work exposures not reported; history of avocational noise exposures and ear disease, not reported; hearing thresholds obtained after exposure with tonal audiometrics and super-threshold tests.

Evaluation : Noise parameter data is poor: noise sources and durations of exposure not reported precisely; environment, instrumentation and measurement procedure not reported.

Health Effects:

CVS Response : Hypertension (no data presented, but BP said to be elevated in 22.2% of Group 1 and 34.7% of Group 2.) No details provided, but states studies of the vegetative nervous system were conducted by means of orthoclinostatic tests, Danini-Ashner reflex and dermographism.

Study of the sympatho-adrenaline system included:

(a) adrenaline content in urine which showed a tendency toward increase in the stable noise group (up to 5.43± 0.55 ng/min compared to 4.45 ± 0.53 ng/min in controls)

(b) a decrease in noradrenaline (control group = 14.7 ± 1.23 ng/min and stable noise group 11.48 ± 1.59 ng/min)

(c) in pulsed noise, the adrenaline content in a one-hour urine increased to a greater degree than in stable noise (up to 6.26 ± 1.29 ng/min)

(d) in pulsed noise, secretion of nonadrenaline was essentially not different from control group values.

: Other health outcomes studied were E.E.G. readings; reported complaints such as headache, sleeplessness and irritability, dizziness, noise in the ears; activation of sinew reflexes; skin vibrational sensitivity and hearing. In 24% of the persons in Group 2 exposed to pulsed noise, a reduction of perception of high tones up to 30-40 dB in the region of 3000-6000 Hz was observed on audiogram; among workers exposed to stable noise, a widely spread impairment of hearing was observed only in singular cases. Pathology in hearing developed earlier with pulsed noise than with stable noise.

Evaluation : No diagnostic criteria or definitions or measurement procedures for health outcomes were given and no data (other than stated above) were provided to the reader. It is not clear to what extent the control group members were assessed for comparison since no data provided for hypertension among the controls. The significance of the "objective measure changes" for cardiovascular disease or other chronic illnesses is unknown.

Judging Causal Significance:

Strength of the Association: No quantitative data provided.
Statistical Methods: No information provided.

Control for Potential Confounders:

Sex, age and length of employment were reported as similar in the groups, but were not considered in analyzing the data. Authors state that there was no vibration in the work places, but studied skin vibrational sensitivity. No evidence of statistically controlling for potential confounders when considering any of the multiple health outcomes. In fact, based on data reported, one would assume the control group was not considered in the major comparisons.

Conclusions:

Authors : "Therefore, the continuous exposure of the organism of the worker to industrial noise can be compared to chronic acoustic stress capable of causing various functional cerebral-visceral disorders."..."It can be assumed that pulsed noise as well as stable noise provokes the stimulation of the adrenaline ring."..."Undoubtedly, the degree of these disorders is related to the character of noise, its intensity, duration, acoustic effect, the functional state of the central nervous system, and the individual sensitivity of the organism to noise irritants."

Overall Evaluation:

Although this study investigates the effect of both steady and impulse noise on a variety of health systems, it is of limited value because it fails to give an adequate description of the methods employed, and provides essentially no data for scientific scrutiny.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method = 3

Citation: Kangelari, S.S., Abramovich-Poliakov, D.K. and Rudenko, V.F.: On the Problem of the Effect of Vibration and Noise on the General Illness Rate. Gigiena Truda i Professional'nye Zabolevaniia 10(6):47-49, June, 1966. (Russian)

Researchers and Institution where research performed: Institute of Occupational Hygiene and Occupational Diseases.

Stated Purpose: Not explicitly stated; implied purpose is to study the effect of vibration and noise on illness rate of workers in industry.

Study Design and Sample:

: Occupational groups of motor mechanics, cleaners in a foundry section and fitters as a control group.

: Cross-sectional study of 135 mechanics and 152 cleaners exposed to noise reaching 116-120 dB with a predominance of frequencies 2500 Hz and higher in its spectral band and an unknown number of fitters working in a general background of 88-90 dB with frequency spectra 120-800 Hz.

: Total group of men aged 20-39 years with 30.8% employed up to three years; 17.3% up to five years and 51.9% for more than five years.

: A separate cross-sectional comparison of cleaners experiencing vibration disease and cleaners of the same area not suffering from vibration illness.

: No information as to how data were collected, what proportion of the work force participated and how the sample was selected.

Data Sources : Not stated.

Bias Potential in Design: Selection and measurement bias possible.

Noise Exposure:

Noise Description:

Source : Diesel motors, pneumatic hammers.

Type : Industrial, nonsteady.

Frequency Composition: Motor mechanics worked in a predominance of frequencies 2500 Hz and higher; spectra of noise shown.

Levels : Motor mechanics - reached 116-120 dB; fitters - less noisy area with 88-90 dB noise level; cleaners - 110-120 dB.

Duration of Exposure: No actual individual exposures given, only the working experience of the subjects.

Instrumentation: Not reported.

Measurement Procedures: Not reported.

Environment : Uncontrolled; motor testing shop and foundry; noise sources relative to worker position is not described.

Subjects : Mechanics subject to motor noise 90-95% of the work time; other worker exposures not reported. No information as to avocational exposures, history of ear disease, hearing thresholds.

Evaluation : Instrumentation and procedures for measuring noise were not reported. Duration of exposure is questionable. Subject data poor. Noise sources relative to positions of the worker and his general environment were not described.

Health Effects:

CVS Response : Sickness rate - all forms of illness; angina; diseases of the peripheral nervous system and other disorders; reported as cases per 100 for a three year period.

Evaluation : No diagnostic criteria and no definitions stated. It is not possible to determine whether an illness was counted once or several times in the three year sick rate. No information provided as to measurement procedures or data sources, but table refers to work capacity based on disability from work days. Angina, usually based on symptoms reported, is a very subjective health outcome.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: No inferential statistics; data presented as proportions.

Control for Potential Confounders:

No evidence of control of any major confounders such as previous illness, age, etc. Report states that carbon oxides and air temperature were within the permissible range for the workers.

Conclusions:

Authors : "...that the motor mechanics had a much higher sick rate index than the control group for flu and acute common colds of the upper respiratory tract, as well as diseases of the nasopharynx, breathing organs, and the gastro-intestinal tract." Angina sick rate 8.9 in motor mechanics and 7.8 (cases per 100) in fitters. "...The indexes of the sick rate for the cleaners suffering from vibration illness are higher for every disease than for the cleaners not suffering from vibration illness."..."The comparison presented in this article does not pretend to offer an exhaustive answer to the question of the influence of noise and vibration on the general illness rate; nonetheless, it seems to introduce a decisive contribution to this area of occupational pathology."

Overall Evaluation:

This study is weak in design, totally lacking in control of potential confounders and for cardiovascular response, employs a very subjective diagnostic entity, angina.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 1
Epidemiologic Method = 2

Citation: Khomulo, P.S., Rodionova, L.P. and Rusinova, A.P.: Changes in the Lipid Metabolism of Man Under Protracted Effect of Industrial Noise on the Central Nervous System. Kardologiia 7:35-38, July, 1967. (Russian)

Researchers and Institution where research performed:
Central Scientific Research Laboratories and the Leningrad S.M. Kirov Continuing Medical Education Institute.

Stated Purpose: To determine the content of cholesterol, beta-lipoproteins, and total lipids in people under the long-term effect of industrial noise.

Study Design and Sample:

: Cross-sectional design.

: 103 persons (69 men and 34 women) who had worked various lengths of time under conditions of high-frequency noise, 117 dB intensity were compared to 51 controls (38 men and 13 women) exposed to permissible noise of middle and low frequencies and intensity from 60-95 dB. The noise exposed workers were observed "over the course of 7 years" with 80 showing noise hearing impairment, 56 suffering from functional disorders of the nervous systen, 3 from hypertension and 3 from arteriosclerosis. Workers in the control group were "practically healthy". Work load was greater for high noise group.

: No information provided as to sampling frame, health state of subjects at beginning of the observation period, baseline values of the cholesterol, beta-lipoproteins and total lipids.

Data Sources : Medical-hygiene records and blood serum tests.

Bias Potential in Design:
Although authors state that the noise exposed group underwent "dynamic observation over the course of 7 years", the tabled data indicate individuals with employments of less than 7 years, suggesting the data are cross-sectional in nature with potential selection bias and unclear antecedent consequence relationships.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Industrial noise; steady or nonsteady not reported, but would probably be nonsteady.
Frequency Composition: Specific frequency components not reported; noise-exposed group: basically high frequency noise and controls worked in middle or low frequency noise.
Levels : Noise-exposed group - 117 dB; controls - 60 to 95 dB; actual levels of exposure for subjects questionable.
Duration of Exposure: Subjects grouped by 1-2, 3-4, 5-9, 10-15, 15-30 years of employment to indicate exposure.

Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled.
Subjects : No information provided as to avocational exposures, hearing thresholds, history of ear disease.
Evaluation : Study weak in all noise parameters.

Health Effects:

CVS Response : Blood serum cholesterol determined by a Liberman-Burkhardt reaction after its extraction with a methanol-chloroform mixture; beta-lipoproteins determined by a turbidimetric method and total lipids by Bergdon's method.
: Neurocirculatory asthenia, hypertension and arteriosclerosis.
: Age of the groups similar, nutrition same based on questionnaire data; blood analysis taken in the morning on an empty stomach or after a breakfast consisting of tea and muffins.
Evaluation : Standard methodology for laboratory studies were used. No diagnostic criteria for health conditions given.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively. The change in cholesterol values with the increase in employment duration among individuals exposed to noise is suggestive of a dose-response relationship, since this increase in cholesterol values does not occur in the control group.
Statistical Methods: p-values, but no statistical test given.

Control for Potential Confounders:

Age, length of employment, specialization and state of the nervous system were considered in the analysis. Nutrition was controlled on the day of testing.

Conclusions:

Authors :"1. Industrial noise with an intensity of 95-117 dB acting during the course of 5 years or longer leads to impairment of the metabolism of lipids in workers. The disorders were manifested as hypercholesterolemia and a tendency toward an increased quantity of total lipids and beta-lipoproteins in blood.

2. The degree of increase in the cholesterol content in the blood depends on the length of employment in conditions of intense industrial noise. After 5-15 years of exposure to industrial noise, endogenous hypercholesterolemia, more pronounced in persons with functional disorders of the nervous system, developed in the majority of the workers."

Overall Evaluation:

The strengths of this study lie in the standard assessment of blood lipids and the exploration of several variables other than noise. The design description implies prospective data may be available, but data are not presented to support other than a cross-sectional strategy.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 7
Epidemiologic Method = 2

Citation: Klotzbuecher, E.: The Effect of Noise on Mental Performance and Selected Physiological Functions. International Archives of Occupational and Environmental Health 37(2):139-155, 1976. (German)

Researchers and Institution where research performed:
Not translated.

Stated Purpose: To check the effect of noise of different intensity towards performance and physiological reactions.

Study Design and Sample:
: Quasi-experimental design.
: 10 healthy, male vocational school students, 17-19 years of age were studied in three test series under the influence of noise of different intensity. Tests conducted in a soundproof room between 8 and 11 o'clock A.M. The test series were randomized to subjects. Physiological functions were assessed throughout the test period and stored on a tape recorder in a modulated form.
: No information provided about subject selection or vocations of the 10 males undergoing the tests.

Data Sources : Experiment.

Bias Potential in Design:
Small sample size; internal validity problems associated with instrumentation and test condition changes over the 12 day testing period.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Wide-band (white) noise.
Frequency Composition: Wide-band (white) noise.
Levels : Three test conditions: wide-band (white) noise=55 dB(AI);
wide-band (white) noise=70 dB(AI);
wide-band (white) noise=85 dB(AI);
test sequence was stocastic.
Duration of Exposure: Intervals for a single test subject lasted approximately 12 days; test groupings were (a) rest, 10 minute sitting without noise; (b) 3 minute rest with noise; (c) 90 minute arithmetic tasks with noise.
Instrumentation: Not reported; no evidence of use of recognized standards.
Measurement Procedure: Not reported.
Environment : Controlled; "dead room of the test laboratory of the German Mail."
Subjects : No information provided as to vocational and avocational exposures, history of ear disease or hearing thresholds.
Evaluation : Laboratory type environment with good description of noise except for failure to report source. Noise measurement procedure and instrumentation were not described. Additional information about subjects is needed.

Health Effects:

CVS Response : Heart rate measured by EKG; respiratory rate by thermister; catecholamines (epinephrine and norepinephrine) determined after a method of Euler and Floding.

Evaluation : Measurements appear valid. It appeared that noise interfered with mental work and epinephrine and norepinephrine excretion increased. The relationship of the observed effects to cardiovascular disease development is unknown.

Judging Causal Significance:

Strength of the Association: Not relevant.

Statistical Methods: t-test for paired differences and correlation coefficients. An ANOVA would be a more appropriate analytical procedure.

Control for Potential Confounders:

The sequence of the test series was random which should control for selection bias, confounding and personal differences given an adequate sample size.

Conclusions:

Author : "The number of significant correlations between performance and physiological reactions decreased a lot more from noise level 55 dB(AI) to noise level 70 dB(AI) than from noise level 70 dB(AI) to 85 dB(AI)"..."The rise of adrenalin secretion under noise strain and mental work found by us is twice as high at 55 dB(AI) as with noise strain."..."The recommended noise level at concentrated mental work should therefore be lower than 55 dB(AI)."

Overall Evaluation:

This quasi-experiment might have been more useful to our purpose of evaluating the association between noise and cardiovascular response had the physiological responses been defined more clearly and the results considered in a manner appropriate for determining a gradient of effect. However, the relationship of catecholamine levels and changes in these levels to cardiovascular disease is unclear at present. Sample size is small.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 4
Epidemiologic Method = 5

Citation: Kobets, G.P., Liubomudrov, V.E., Dokukina, G.A., Vasilyev, V.N. and Gurkonskaya, S.M.: On the Non-Specific Effect of Industrial Noise and Vibration. Vrachneboe Delo 2(2):134-137, February, 1972. (Russian)

Researchers and Institution where research performed:
Donetsk Medical Institute and Regional Clinical Hospital of Occupational Diseases.

Stated Purpose: To provide a more detailed illumination of the non-specific effects of industrial noise and vibration by studying the state of health according to the data of a comprehensive medical examination and analysis of the indexes of the sick rate (temporary work disability) for three years with a calculation of the annual index among women of various professions.

Study Design and Sample:
: Cross-sectional comparison of medical examination data and annual disability index for a convenient sample of women from the following occupations:
: 446 women employed in product warehouses and storage in work processes requiring physical stress with mean age of 38 ± 0.4 years and 14 ± 0.3 years employment;
: 390 practically healthy persons - mean age 36 ± 0.4 and 12 ± 0.2 years employment;
: 147 female concrete workers - mean age 37 ± 0.6 and 10 ± 0.3 years employment and exposed to vibrations;
: 144 women 34 ± 0.4 years of age with an average of 7 ± 0.3 years employment who were "subject to the effect of noise";
: 89 persons suffering from noise disease (37 ± 0.8 years of age and 9 ± 0.6 years employment).

Data Sources : Medical examination and disability records.

Bias Potential in Design:
Selection bias may exist since the jobs studied were of such variability suggesting a great deal of self-selection; response rate and sampling frame not known; potential measurement bias with use of extant disability records. Comparability of work environments on factors other than noise and vibration questionable.

Noise Exposure:
Noise Description:
Source : Not reported - merely state that noise was "in electro-pneumatic sections of metallurgic plants".
Type : Industrial noise; steady or nonsteady is not reported.
Frequency Composition: High frequency (predominately in 1200-1800 Hz range) for women subject to effect of noise and suffering from noise diseases.
Levels : 112-122 dB (for groups also experiencing high frequency).
Duration of Exposure: Years of employment used to estimate exposure.

Instrumentation: Not reported.
Measurement Procedure: Not described.
Environment : Uncontrolled; not described.
Subjects : Possibility of other than one vocational exposure not considered; history of avocational noise exposure, ear disease, hearing thresholds were not reported. It is presumed that otological examinations were completed on basis of otolaryngologist diagnosis being available.
Evaluation : Actual noise exposure data is questionable. Difficult to determine the actual groups compared and the relevant noise levels. Noise sources not identified. Instrumentation and noise measurement procedures and subject information was not reported. Noise environments not described.

Health Effects:
CVS Response : Disorders of the regulation of the arterial blood pressure, functional disorders of the heart action, temporary work disability (annual index). Also studied respiratory illness and ulcers and other complaints.
Evaluation : No diagnostic criteria given although diagnosis was "by specialist". No criteria stated for hypertension, hypotension, functional diseases of the heart or vibration disease. Measurement and testing procedures not described.

Judging Causal Significance:
Strength of the Association: States that disorders of the regulation of the arterial blood pressure, in the direction of higher as well as lower were 5-8 times more frequent among those subject to the effect of vibration and noise than in the control group. However, no data are shown and direction is not given.
Statistical Methods: None reported.

Control for Potential Confounding:
No evidence of controlling for confounding, but conclusions are presented without supporting data.

Conclusions:
Authors : "While it can be fully confirmed that the specific disease and disorders (arterial hypertension or hypotension, functional disorders of heart action, neurosis) are consequences to a certain degree of the specific effects of tha named hazards, the injuries of the upper respiratory passages, chronic gastritis and ulcers, and cholangiohepatitis can hardly be traced to their specific effect." The index of cases of the sick rate (total data) was lowest in the control group, rose 2.5 times in workers subject to the effect of noise, increased 3.9 times with development of noise illness, 3.2 times in healthy concrete workers and 3.9 times in individuals with vibration disease.

Overall Evaluation:

The groups under investigation with their respective noise and outcome measures are virtually impossible to identify in this article (and/or its translation). No data are provided to support the conclusions. The direction of the observed associations between blood pressure and noise levels are not clearly presented.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 1
Epidemiologic Method = 3

Citation: Koszarny, Z., Maziarka, S. and Szata, W.: The Effect of Airplane Noise on the Residents of Regions in the Area of the Airport Okecie in Warsaw. Roczniki Panstwowego Zakladu Higieny 27(2):113-121, 1976. (Polish)

Researchers and Institution where research performed:
Municipal Hygiene Section of the State Health Institute, Warsaw.

Stated Purpose: To evaluate the state of health and noise complaints in persons living in the area of the Okecie airport.

Study Design and Sample:
: Community survey.
: Cross-sectional data.
: 256 residents living in a zone with noise greater than 100 dB(A) and 255 residents of an area with a noise level of 80-90 dB(A); areas represented equally by men and women 20-70 years of age, with similar education type, occupation and working conditions; areas varied on housing-living conditions.
: Sampling frame and sampling method, response rate not described, although referenced as same as the previous study in 1975.

Data Sources : Not described in this paper, referenced to previous study; community type survey using a detailed health questionnaire is presumed.

Bias Potential in Design:
. Potential for self-selection bias, non-respondent bias and selective recall. Since there are no actual individual noise exposures available, there is the potential for ecologic fallacy in interpreting the results.

Noise Exposure:
Noise Description:
Source : Air traffic, street noise, neighborhood residences, service establishments, factories, railroad noise, household devices; actual objects producing noise were not identified.
Type : Variety of types.
Frequency Composition: Not reported.
Levels : Area A, noise was higher than 100 dB(A)
Area B, noise was 80-90 dB(A)
Duration of Exposure: Not reported.
Instrumentation: Not reported in this paper.
Measurement Procedure: Not reported.
Environment : Not specified; uncontrolled.
Subjects : No information provided as to vocational or specific avocational noise exposure, hearing thresholds or history of ear disease.
Evaluation : Noise parameter is very inadequately described. Paper references a previous study for questionnaire development, but is not specific relative to noise.

Health Effects:

CVS Response : Frequency of occurrence of symptoms as indexes of the state of health; symptoms included taking cardiac medicines, heart pains, nervousness.

Evaluation : No objective measures employed. No information as to method by which symptom data were collected. Very weak outcome measures employed.

Judging Causal Significance:

Strength of the Association: Not stated. Symptom frequency was high in both areas; significant differences were found between women in the worst acoustic condition and other women as to occurrence of complaints of heart pain, taking of headache and cardiac medicine and frequent irritation.

Statistical Methods: Chi-square and t-test. Table III presents data in percentages and displays a t-test value which would not be an appropriate statistic; it can probably be assumed that the Guttmann method for analyzing scalegram data utilizes mean values.

Control for Potential Confounders:

Groups shown to be similar on types of education, occupation, working conditions; groups vary on housing-living conditions which may influence results by raising the sensitivity to noise of persons exposed to unfavorable conditions, but authors state this is not likely to influence results since the residents in the lower noise area reported more dissatisfaction with living conditions and less modern housing.

Conclusions:

Authors : "Airport noise of a level above 100 dB(A) is a significant burden for the residents." Burdensomeness of airport noise at 100 dB(A) equalled 82% and at 80-90 dB(A) was 54%. Correlation between the hampering effect and actual noise level was low taking into account individual sensitivity of subjects, suggesting perceptions and personal factors were important. "The relationship between some symptoms of aggravation and ill health and the acoustic conditions in the place of residence indicates the probability of the negative influence of airport noise on the residents' state of health." The high percentage of persons complaining of symptoms and the frequent occurrence of symptoms of illness among women, but not men, from the worst acoustic conditions seems to support the relationship between airport noise and the state of health. "On the other hand, one cannot exclude the assumption that the above mentioned indexes result from other unfavorable effects of the environment, especially the work environment."

Overall Evaluation:

This study suffers from poor specification of the noise and health parameters on the basis of the data presented, and from many possible biases. It is unclear as to how equal numbers of subjects with such similar demographic characteristics were selected from the two areas without introducing selection bias. Findings contribute little to the understanding of the relationship of noise to health effects.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects =
Epidemiologic Method = 2

Citation: Lanzetta, T., Giovanazzi, A. and Furlanello, F.: Prospects for the Use of Dynamic Electrocardiography During Work Activity of Subjects Exposed to Environmental Noise. Minerva Cardioangiol. 27(9):559-566, 1979. (Italian)

Researchers and Institution where research performed:

Lanzetta and Furlanello - Division of Cardiology, Istituti Ospedalieri, Trento, Italy.

Giovanazzi - Servizio Provinciale di Medicina Preventiva dell'Eta Lavorativa, Trento, Italy.

Stated Purpose: To check the possibility that electrocardiographs would reveal the effects on the cardiovascular system, as a response to rate, to rhythm disturbances, and/or changes in the ventricular repolarization phase in the workers at the time of exposure and non-exposure to environmental noise, in comparison to workers not exposed to such noise.

Study Design and Sample:

: Short-term exposure effects investigated.

: 17 workers with 12 exposed to noise of two different work environments and 5 not exposed to "substantial" noise. Of the exposed, 8 had normal hearing and 4 had hearing impairments; the 5 controls had evidently normal hearing. The study began 3½ hours after the start of the work day and ended 2 hours after the end of work, thus including 4½ hours of unbroken exposure to noise and 2 successive hours of rest.

: Cross-sectional comparison of the group on serial EKG measurements.

: Selection of sample was not described; no evidence of random selection.

Data Sources : Dynamic EKG recordings and a diary kept by subjects.

Bias Potential in Design:

Selection bias; although the control subjects were said to have equivalent work duties, there is little evidence of comparability and no evidence of random selection of subjects; potential bias due to unknown effects of grouping individuals from 2 different noise environments of unknown variability in previous exposure to noise; very small sample size.

Noise Exposure:

Noise Description:

Source : Not reported.

Type : "Environmental" noise in a factory; not reported as to steady or nonsteady noise type.

Frequency Composition: Not reported.

Levels : One work environment: 91 dBA; another work environment: 101 dBA; controls: not given.

Duration of Exposure: 4½ hours of exposure to usual work noise on the day of testing; previous noise exposure evidently not considered. Not clear whether hearing impaired subjects were working in one or both noise environments.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; not described with any details.

Subjects : Current and past job exposures not considered other than on exposure on day of testing; no avocational noise exposures reported. Age and sex of subjects not given. It is presumed that testing of hearing thresholds was obtained based on the statement that audiograms were interpreted for the noise-exposed group according to directions of the A.A.O.O.

Evaluation : Noise source, frequency composition, instrumentation and procedure for measuring noise were not reported. Duration of noise exposure is questionable. Data poor for an adequate noise evaluation.

Health Effects:

CVS Response : Holter (dynamic) monitoring of heart rate, arrhythmias and ST-T differences (repolarization).

Evaluation : Clinical significance of heart rate response unknown for long-term effects. Accuracy of diary notes are critical to analysis; details not given. There is no evidence of quality control of the data.

Judging Causal Significance:

Strength of the Association: Not relevant for long-term exposure.

Statistical Methods: p-values given, but no information provided as to methodology employed.

Control for Potential Confounders:

The workers were free of obvious disease; in all subjects the EKG made under basic conditions was normal; subjects were said to avoid carbon disulfide, trichloroethylene, lead, cadmium, carbon monoxide, mercury, high environmental temperatures ; recorded physical effort, perceptions, alcohol and coffee intake, smoking while being tested. The extent to which any or all of these variables were considered in the analysis is unclear.

Conclusions:

Authors : "The increase in the cardiac rate was indeed constant in the groups 'exposed' with normal auditory capacity, was maintained throughout the work shift, and re-entered the normal limits only after cessation of work. The results were statistically significant in comparison with the group of workers 'not exposed' to noise and with those with hearing impairments. It is interesting to observe the persistence of the response in the increase in cardiac rate (under exposure) to environmental noise, even after many years of exposure to this noise." For workers exposed to noise $\leq$ 1 year to 3 years, the recovery of the base cardiac rate occurred within 44 minutes; for those exposed 4-21 years, the recovery occurred between 58-120 minutes; it was not possible to establish a linear relation between recovery time and biological age of worker.

Overall Evaluation:

This study of short-term EKG responses to noise suggests that future research is needed. However, the small sample size, the multiple variables considered, and the unclear methodology employed reduces its scientific value in evaluating the effects of noise on workers. Holter EKG monitoring with concommittent noise level monitoring may be of value in future studies.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 8
Epidemiologic Method = 4

Citation: Liubashevskaia, Z.A. and Solonin, Iu.G.: Effective Measures of Improving Working Conditions in Forging and Pressing Shops. Gig. Tr. Prof. Zabol 7:46-48, 1976. (Russian)

Researchers and Institution where research performed:
Uralmashzovod Factory, Institute of Occupational Hygiene and Occupational Diseases.

Stated Purpose: Study performed for the physiological and sanitary evaluation of the work performed and of the implementation of measures intended to improve working conditions.

Study Design and Sample:

: 28 workers: 16 forge workers in 29 shifts; 12 apprentices in 19 shifts, aged 22-54 years. At beginning of study 15 forge workers and 15 apprentices after improvements;

: Measures taken before-after implementation of improvements, but apparently cross-sectional comparisons were made (comparison of group values at T_1 to a different group at T_2);

: Sampling frame, determination of sample size not described.

Data Sources: Not described.

Bias Potential in Design:

Internal validity problems related to history, aging, changes in instrumentation and conditions of testing, selection bias, and multiple changes in the work environment over the three year period studied.

Noise Exposure:
Noise Description:
Source : Stamping and forging hammers.
Type : Industrial in forging and pressing shops; unsteady presumed, but not reported.
Frequency Composition: Not reported.
Levels: General noise level before improvements: 95 dB average, 78-120 dB range; after improvements (over a 3 yr. period): 90 dB average, 71-110 dB range.
Duration of Exposure: Although shift information is reported, the actual exposures of the workers to noise is not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; forging and pressing shop; layout not described regarding working relationship to the noise sources.
Subjects : History of vocational exposure for individual workers was not reported, but study indicates workers took up second occupation such as stamper and presser; no data as to history of avocational exposure, hearing threshold levels, history of ear disease.
Evaluation : Poor study relative to reporting of noise parameters, noise measurement, environment and subjects.

Health Effects:

CVS Response : Repeated physiological examinations of functional strain on the circulatory and thermoregulatory systems; systolic and diastolic arterial pressure, skin temperature, body temperature, muscle strength and endurance of workers. No information provided as to measurement techniques, criteria for assessment and no data provided showing blood pressure readings in any form. Methods for analyzing multiple readings in a worker group that changed in composition is not given.

Evaluation : Data totally inadequate for judging quality or quantity of health measures.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Not stated. No health data presented to support conclusions regarding blood pressure.

Control for Potential Confounders:

No evidence of any type control; "before-after" comparisons appear to be cross-sectional rather than related to the same population.

Conclusions:

Authors : "Arterial pressure (systolic and diastolic) had a decreasing tendency at the end of the shift"..."Repeated physiological examinations in 15 forge workers and 15 apprentices showed a decrease in the functional strain upon the organism...The measures implemented were effective from the economic and physiological-hygienic points of view, and can be recommended for other plants."

Overall Evaluation:

Apparently a very poorly designed study with multiple "improvements" made over the 3 year study period and many potential confounding factors present which were not considered. From the paper it is impossible to determine comparisons made or physiological data that were actually available. Translation obtained was poor, but not likely to account for most of the problems.

(Scores on scale from 0-9)

Noise Exposure = 2
Health Effects = 0
Epidemiologic Method = 0

Citation: Mariniako, A.Z. and Lipovoi, V.V.: An Estimate of the Total Time of Individual Noise Effects in Hygienic Evaluation of Intermittent Noises. Gigiena Truda i Professional'nye Zabolevaniia 2:15-18, 1975. (Russian)

Researchers and Institution where research performed:
Not stated.

Stated Purpose: To study the characteristics of the influence of some aspects of intermittent noise in comparison with stable noise with uniform summary length of effects.

Study Design and Sample:

: Quasi-experimental design using 20 practically healthy males 18-25 years old in a soundproof chamber exposed to four conditions of noise. Twenty observations were made in each of the four series.
Series 1: low frequency noise, steady noise;
Series 2: low frequency noise with intermittent effects - 2½ minutes of noise alternating with 5 minute intervals for a total of one hour noise and two hours rest, noise similar to work in concrete packing;
Series 3: high frequency stable noise at 105 dB;
Series 4: intermittent sound with ½ minute high frequency at 105 dB, alternating with ½ minute pauses for a total of one hour noise and one hour rest, noise similar to hydraulic testing of pipes.

: No information provided on selection of subjects, allocation of subjects to the groups for testing, exposure of subjects to noise in the workplace.

Data Sources : It is assumed that all data were derived from the experimental situation.

Bias Potential in Design:
Selection into sample; bias due to lack of a control in the sense that subjects were not tested under control or low noise conditions; bias resulting from failure to randomize either subjects or the noise conditions.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Intermittent (nonsteady) and stable (steady).
Frequency Composition: Series 1: Low frequency, maximum energy around 250 Hz
Series 2: low frequency, maximum energy around 250 Hz
Series 3: high frequency (maximum energy around 2000 Hz)
Series 4: high frequency
Levels : Series 1: 110 dB
Series 2: 110 dB
Series 3: 105 dB
Series 4: 105 dB

Duration of Exposure: In each series, subjects exposed to noise 1 hour.
Series 1: Steady
Series 2: Intermittent with noise presented 2½ minutes and no noise 5 minute intervals (3 hours)
Series 3: Steady
Series 4: Intermittent with ½ minute of noise and ½ minute of no noise interval (2 hours)

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Controlled soundproof chamber; relationship of noise source to subject not reported. Whether noise was presented through loudspeakers or earphones is not stated.

Subjects : Twenty "practically healthy" males studied with no history of vocational or avocational noise exposure reported, no information regarding ear disease. Hearing sensitivity was determined with an audiometer at pitches of 500, 1000, 2000, 4000 and 6000 Hz (air conduction).

Evaluation : Although noise parameters were reported, the noise source, instrumentation, and procedure for measuring noise were not. The testing environment was not described beyond a "soundproof chamber" which is not very informative. Little subject data are available to the reader.

Health Effects:

CVS Response : The tone of the vessels as measured by the amplitude of the plethysmogram for the index finger (volume differences); pulse rate; and time and accuracy response to lights.

Evaluation : No data provided as to measurement procedure. The relationships of the response to noise exposure described. The decrease in pulse pressure with noise is consistent with findings from other studies and appears to suggest cardiovascular adaptation to continuous noise.

Judging Causal Significance:

Strength of the Association: Not stated; not appropriate study for long-term exposure. For the first minute of the effect of stable and intermittent noises, the amplitude of the plethysmogram was, respectively, 65% and 62% of the initial level; at the 50th minute of noise, it was 72% under stable noise and 52% under intermittent. The immediate decline would appear to indicate a noise effect, but the strength of the association is unclear in these limited data.

Statistical Methods: Statistical significance indicated, but no test stated.

Control for Potential Confounders:

No control of any potential confounders; apparently no randomization of subjects or noise treatments.

Conclusions:

Authors : "A rather noticeable difference in the effects of stable and intermittent noise (especially with high frequency compositions) was noticed in the study of the tone of the vessels."..."After one hour of effects of stable and intermittent noises, a tendency toward decline in pulse frequency, on the average of 2-3 per minute, was observed."

Overall Evaluation:

Design inadequate for consideration of this study as a true experiment. However, it does suggest an adverse health effect from noise with intermittent sound leading to a greater degree of vasoconstriction than stable noise.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effect = 6
Epidemiologic Method = 3

Citation: Meinhart, P. and Renker, U.: Examination of the Morbidity on Heart and Circulatory Diseases Through Permanent Noise Exposure. Zeitschrift fur die Gesamte Hygiene und ihre Grezgebiete 16:853-857, November 1970. (German)

Researchers and Institution where research performed:
Hygiene Institute of Martin Luther University, Halle-Wittenberg, Germany.

Stated Purpose: To study the connection between year-long noise exposure and heart-circulatory diseases in the industrial area of the District Halle.

Study Design and Sample:
: Cross-sectional data.
: Comparison of 807 males with noise-conditional hearing defects as of December 31, 1965, of the Industrial District Halle with representative morbidity statistics of 3948 from communal health institutions of the same district. Implied that noise categories of Lehmann were used and divided by 30-65 phons, 65-90 phons and above 90 phons, but no evidence of classification of individual subjects by phons. No data as to noise exposure of comparison group.

Data Sources : Medical records ordered by the Labor-sanitary inspection and record data of several ambulatory clinics of the district.

Bias Potential in Design:
Potential for selection bias among both hearing defect and comparison group from clinics. Completeness of noise-defect sample and/or sampling frame is unknown. Demographic characteristics of both groups not reported. Data may suffer from ecological fallacy since actual noise exposures of the individuals within the study and comparison group are unknown.

Noise Exposure:
Noise Description:
Source : Noise from industrial area of district Halle, no specifics given.
Type : Not reported.
Frequency Composition: Not reported.
Levels : Not reported specific for study group but implied that categories of 30-65 phons, 65-90 phons and above 90 phons were used with noise-conditional hearing defects coming from the above 90 phons category.
Duration of Exposure: Presented in graph form with no details for the 807 workers and categorized as 0-5 years, 5-10 years, 10-15 years, 15-20 years and 20 and over years. It is presumed that these years represent years of employment.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; details not reported.

Subjects : No information provided other than vocational exposure as described above under duration of exposure. Hearing thresholds, history of ear disease, avocational exposures unknown.

Evaluation : Virtually no information provided regarding the manner in which noise was quantified in the industrial environment and no definitions of noise-injury provided for evaluation.

Health Effects:

CVS Response : Six categories of response were noted: all circulatory diseases, functional heart and circulatory diseases, coronarsclerosis and myocardium injury, hypertension, hypotension and peripheral perfusion disturbances (peripheral vascular disease?).

Evaluation : Data apparently derived from a survey including history, blood pressure, clinical findings and from ambulatory clinic records. No information provided as to diagnostic criteria, measurement or quality control of the assessments. Definitions of hypertonia (hypertension) and hypotonia (hypotension) not provided. Blood pressure levels are not available in the data for evaluation.

Judging Causal Significance:

Strength of the Association: Prevalence of myocardial injuries for total group reported to be twice as high for the noise-injured (3.6%) as compared to the "normal" population (1.75%) with no cases observed among controls 15-40 years of age compared to a rate of 1.8 among noise-injured of similar age. The prevalence ratio of hypertension between the noise-injured and controls for 12-40 year olds = 7.6, for 40-65 year olds = 9.7 and for 65+ = 8.2 and was reported to be highly significant. For the younger age groups, hypotension was higher among the noise-impaired than the clinic population. No differences were observed for functional heart-circulatory diseases and peripheral perfusion disturbances. Temporal relationships may not be inferred from the cross-sectional data.

A dose-response relationship was reported on the basis of length of employment: for all age classes, the frequency of heart-circulatory diseases and especially hypertension and hypotension began rising after five years employment and rose precipitously after 20 years of employment. Age effects not taken into account.

Statistical Methods: Levels of statistical significance reported but no specific methodology described.

Control for Potential Confounders:

It appears that the investigators separately controlled for age and duration of exposure although considering duration of exposure effects while controlling for age would have been more informative. Noise-impaired subjects were all males and controls were assumed to be of same sex. No data are provided as to control for socio-economic status, work status, co-morbidities or medications taken. From the data presented in tabular form, co-morbidities were observed in both groups. Although blood pressure probably changed with onset of myocardial injuries and/or treatment, no attempt was made to control for blood pressure levels in the heart disease analysis.

Conclusions:

Authors : The prevalence of myocardial injuries was about twice as high for the noise-injured group as the controls; hypertension was higher among noise-impaired in each age group; hypotension was higher among noise-impaired at all ages except the 65 and older; for all age classes, the frequency of heart circulatory diseases and especially hypertension and hypotension began rising after five years employment and rose precipitously after 20 years work; no differences between the groups were observed for functional heart-circulatory diseases or peripheral perfusion disturbances. "The steady noise influence is an important factor of the origin of heart-circulatory diseases."

Overall Evaluation:

This cross-sectional study of hearing-impaired males and patients from ambulatory clinics reports very strong associations between noise exposure and cardiovascular and circulatory problems. Virtually no information is provided the reader as to the manner in which the exposure nor the outcome variables were specified. Even if one is willing to assume that the subjects were adequately assessed on the variables of interest, these observations would be questionable because of the strong possibility of bias from selection of "sick" workers into the noise-impaired group and the selection of "the less sick" from the ambulatory clinic.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 2
Epidemiologic Method = 4

Citation: Paranko, N.M., Vyshchipan, V.F. and Naumenko, B.S.: Stable Functional Changes in Miners Under the Effect of Permissible Levels of Vibration and Noise. Vrachebnoe Delo 2:122-126, February, 1974. (Russian)

Researchers and Institution where research performed:
Scientific Research Institute of Hygiene and Occupational Diseases, Krivoi Rog.

Stated Purpose: To determine the effect of the permissible levels of vibration and noise on the organism of the miner and the possible occurrence of occupational illnesses.

Study Design and Sample:

: Occupational groups - drillers and sinkers using protection from sound and vibration.

: Cross-sectional study conducted at two mines at the beginning of work, after an 18-48 hour rest.

: 103 men: 61 drillers and 42 sinkers; 62 were ages 30-40 years and the remainder were 41-50 years of age. Group only partially described by length of employment.

: Apparently no control or comparison group.

: Sample selection and response rate not given.

Data Sources : Not specifically stated: "in addition to complaints of subjects and the neurological status, we studied the data gathered from supplementary methods."

Bias Potential in Design:
Selection bias, selective survival and selective recall. Failure to specify a comparison group severely restricts inferences which can be drawn from these data. Authors apparently "compare" their observations to findings from other studies in the literature.

Noise Exposure:
Noise Description:
Source : Miners' handdrills with KR-IA type vibration cleaners (used on drills for 5-7 years); other sources of mine noise not reported.
Type : Industrial mine noise; steady or nonsteady not reported.
Frequency Composition: Not specified; highest levels located in the high frequencies based upon measurements for a previous study.
Levels : Workers wore anti-noise helmets VTSNIIOT-2M and others. Authors estimate 85 dB SPL based on measurements and hearing protection data from previous studies. No current measures.
Duration of Exposure: Length of employment used as an estimation of noise exposure.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; two mines; not described.
Subjects : Vocational exposures other than mining are not reported; employment does not assure comparable noise exposure between subjects. History of avocational noise exposures and

history of ear disease not reported. Although hearing thresholds and procedures for obtaining them are not reported, the authors state they proceeded on the recommendation of Ponomareva and Ostapkovick in evaluating hearing loss. Tests at 125, 500 and 4000 Hz are indicated in tabled data.

Evaluation : Study is very poor in specifying the noise parameter.

Health Effects:

CVS Response : Arterial blood pressure with an increase defined as 130/90 mm Hg. and more for persons less than 40 years of age and 140/90 mm Hg. for persons older than 40 years; heart rate with quickening defined as > 80 per minute, slackening to < 70 per minute. Responses other than CVS included hearing loss, complaints, sexual activity, lowering of pain sensitivity and lowering of vibration sensitivity, lowering of skin temperature, and increase in visual motor-reaction time.

Evaluation : No information provided as to measurement procedures employed or quality control of the data. No blood pressure or heart rate data provided other than "frequency of appearance" of increase of arterial pressure and pulse rate quickening. Thus, findings are difficult to evaluate.

Judging Causal Significance:

Strength of the Association: Data not appropriate. Data show an increasing proportion of workers with high BP as length of employment increases, except for employment 16 or more years. Age is not controlled and selective forces are not considered.

Statistical Methods: Not given, if applied.

Control for Potential Confounders:

No evidence of any attempt to control for possible confounding variables such as age when considering the effects of noise on blood pressure and pulse rate.

Conclusions:

Authors : "Thus, the results presented show that in miners exposed to the effect of vibration and noise at levels allowable by hygienic norms, stable functional shifts develop. However, their development occurs more slowly than in those exposed to the effect of vibration and noise of high parameters."

Overall Evaluation:

For our purposes, this study is of little value because of its failure to employ an adequate control group and to specify the health and noise parameters in detail.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 4
Epidemiologic Method = 0

Citation: Pilawska, H., Mikulski, T., Rusin, J., Soroka, M. and Wysocki, K.: The Effect of Acoustic Microclimate in the Shipyard Upon the Occurrence of Disturbances in Workers' Health. Medycyna Pracy 28 (5):441-447, 1977. (Polish)

Researchers and Institution where research performed:

The Zakladu Institute of Hygiene, Poland.

Stated Purpose: To analyze the effect of the "noise-pollution level (NPL)" on the state of the workers health in a large industrial plant, the Szczecin shipyard.

Study Design and Sample:

: Cross-sectional design.

: Workers in a large shipyard divided into two groups: 1826 who were exposed to external noise with $L_{qM} > 85$ dB, longer than five hours a day at work and 5825 who were working in an area with external noise not exceeding 75 dB ($L_{qM} < 75$ dB). Sample represented 67.5% of the total employees and were apparently all of the workers examined in the industrial clinic in 1975.

Data Sources : Medical records of periodic examinations available in the Institute of Health Care and year-long measurements of noise in accordance with directives given by the Ministry of Administration, Local Economy and Environmental Protection.

Bias Potential in Design:

Potential non-respondent bias since only 67.5% of the workers were represented and response rate for noise-exposed and non-exposed group was not given. Since the analysis is based on existing medical data from periodic examinations by the 13 doctors serving the workers, diagnostic and exposure suspicion bias may be operating. Data are inadequate to explore the possibility that the increase of proportion of illness involving hearing and hypertension and decrease of psychic disturbances as a cause of medical leaves were related to the clinician's presumption of noise as a "cause" of these problems.

Noise Exposure:

Noise Description:

Source : Multiple sources on the grounds of the shipyard were listed.

Type : Shipyard noise in large industrial plants; nonsteady.

Frequency Composition: Not reported.

Levels : Group A > 85 dB L_{qM} (Quasi-Maximum Noise Levels); Group B < 75 dB L_{qM}; upper limits of noise not reported.

Duration of Exposure: Group A - longer than five hours daily at work; Group B - no duration given.

Instrumentation: Used two N.201 precision measuring instruments with a capacitative microphone under directives of Ministry of Administration, Local Economy and Environmental Protection.

Measurement Procedure: Year-long measurements; measured in dBA at several equally distributed measuring points with three reference points for 24 hour measurements of noise level. From these measurements two (daytime and evening) characteristic periods were selected with no measurement section less than ten minutes. The Noise Pollution Level (NPL) method was used.

Environment : Controlled with shipyard plant divided into three parts for measurement, each part measured separately using nine daytime measurement points and twelve night-time points.

Subjects : History of exposures at job locations other than shipyard and avocational noise exposures not given. Presumably hearing thresholds and history of ear disease were determined in the assessment of hearing damage.

Evaluation : The study is good relative to noise measurements; however the frequency composition and the amount by which noise levels exceeded 85 dB in specific areas would have been useful information.

Health Effects:

CVS Response : Hypertension; no diagnostic criteria or definitions provided. Other responses studied were hearing damage, ulceration of the stomach, psychic disturbances, absenteeisms.

Evaluation : Inadequate information to evaluate the quality of the measurement, however, the fact that the data were derived from documentation of periodic examinations performed by 13 doctors of the clinic suggest variability in the accuracy and reliability of the health outcome measures.

Judging Causal Significance:

Strength of the Association: The frequency of hypertension found in the noise exposed workers was double that of the non-exposed, not taking into account age or length of employment. The stronger associations observed were that hearing damage was 22 times more frequent and ulceration of the stomach 5 times more frequent in the exposed than the non-exposed group. There was no evidence of a dose-response relationship; frequency of hypertension by age and length of employment not shown.

Statistical Method: Data analyzed for significant differences in the frequency of occurrence of health problems; specific tests not stated.

Control for Potential Confounders:

Sex, age, weight, history of disease and treatment were apparently not controlled in the analysis.

Conclusions:

Authors : "Significantly higher numbers of differences in the state of health detected in workers during periodic examinations, such as hearing damage, ulceration of the stomach and duodenum, and psychic disturbances and neurosis in the group of workers who were in the zone of high noise level during work, were confirmed."..."Smaller differences, but also statistically significant, occur in the frequency of hypertension found in both groups (more than double in group A)."

Overall Evaluation:

The major strength of this study was the specification of noise measurements. Unfortunately health responses were not well defined and the response of interest, hypertension, was not analyzed by age, length of employment or hearing damage. There is a distinct possibility of selection bias.

(Scores on a scale of 0-9)

Noise Exposure = 7
Health Effects = 2
Epidemiologic Method = 4

Citation: Pokrovskii, N.N.: On the Influence of Industrial Noise on the Level of Blood Pressure in Workers of the Machine Building Industry. Gigiena Truda i Professional'nye Zabolevaniia 10:44-46, December, 1966. (Russian)

Researchers and Institution where research performed:
Institute of Epidemiology, Microbiology and Hygiene.

Stated Purpose: To study the effect of industrial noise on the level of blood pressure in workers of the machine building industry.

Study Design and Sample:
: Occupational groups of men working in the machine building industry.
: Cross-sectional study of 995 fitters and lathe operators, ages 17-55 years.
: 408 men exposed to medium frequency stable noise with an intensity of 80-85 dB were compared to 587 workers under exposure to high frequency pulsed noise with an intensity of 90-95 dB.
: No information provided as to sample selection and non-response.

Data Sources : Not specified, but apparently collected for study purposes in the plant health clinic.

Bias Potential in Design:
Selection and non-response bias; measurement bias. Prevalence data prohibits determination of the temporal relationships between noise exposure and disease onset.

Noise Exposure:
Noise Description:
Source : Not specified; workers were in the machine building industry.
Type : Industrial; stable and pulsed (nonsteady) noise.
Frequency Composition: Group 1: medium frequency (stable);
Group 2: high frequency (pulsed).
: Noise spectrum not reported.
Levels : Group 1: 80-85 dB;
Group 2: 90-95 dB;
In addition, 120 workers were studied regarding oscillation of blood pressure when exposed to 90-95 dB pulsed noise.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedures: Not reported.
Environment : Uncontrolled; not described.
Subjects : History of vocational and avocational noise exposures not stated; apparently intended ages of subjects to reflect exposure. History of ear disease and hearing thresholds not obtained.
Evaluation : Frequency composition description is very general. Duration and source of noise, instrumentation and procedure

for measuring noise were not reported. Subject information lacking and noise environment not described.

Health Effects:

CVS Response : Blood pressure measured with a Riva-Rocci sphygmomanometer during first 2-3 hours of a morning shift, after 15-20 minutes rest, in plant clinic, method of evaluation according to Rosin for classifying as hypotension, diastolic hypotension, systolic hypertension, "decapitated" hypertension and hypertonic condition.

: Oscillations of blood pressure (changes in BP during exposure) were measured in 120 workers during lunch breaks and at the end of the shift.

: EKG tests on 71 workers 20-40 years old, exposed to 80-85 dB noise and 113 workers exposed to 90-95 dB noise, to determine brachycardia and tachycardia.

Evaluation : Apparently the criteria of Rosin for defining blood pressure differences are an appropriate standard. It is assumed that multiple observers in the clinic recorded the blood pressure. No information is provided as to reliability of the data or whether or not the observers were aware of noise exposure status of subjects. It is unclear when in the course of the day and under what conditions the oscillation measurements were taken. The associations found and significance of the elevated and lowered blood pressures are unclear.

Judging Causal Significance:

Strength of the Association: The average dispersion of oscillations of diastolic BP in workers with normal blood pressure exposed to impulse noise of 90-95 dB was 3.87 times higher than in persons working under 80-85 dB noise; in persons with hypotension exposed to 90-95 dB noise, oscillations of pressure were 4.97 times higher than in persons with normal pressure exposed to 80-85 dB noise. Brachycardia or tachycardia occurred on the average 5 times higher for persons exposed to intense noise than for the controls. The systolic blood pressure of workers 17-30 years of age exposed to 90-95 dB noise was 4-5 mm Hg. lower than comparable aged workers in low noise; older workers exposed to high noise levels showed systolic pressure 3-4 mm Hg. higher than controls of comparable age.

Statistical Methods: Test according to Fisher.

Control for Potential Confounders:

Age partially controlled by stratification. No evidence of controlling for family history, kidney disease, obesity, exercise, blood pressure medications.

Conclusions:

Author : "1. Under the influence of intense industrial noise, the arterial pressure of workers can change in relation to individual characteristics in both directions: toward its increase, and toward its decrease as well.

2. In persons exposed to the systematic effect of intense noise, blood pressure is characterized by more pronounced oscillations."

Overall Evaluation:

This cross-sectional study is methodologically weak for inferring associations between noise exposure and hypertensive disease. Potential selection bias and failure to control for confounding factors and poor documentation of the noise exposure are major problems.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effect = 2
Epidemiologic Method = 3

Citation: Quaas, M., Geiller, W., Platzbecker, I.U. and Zoellner, G.: Vegetative Changes Under the Effect of a 90 dB Broad-Band Noise with Partially Decreased Stimulation of the Acoustic Receptor During a Medium Physical Load. Zeitschrift für die Gesamte Hygiene und ihre Grenzgebiete 16:405-409, June, 1970. (German)

Researchers and Institution where research performed:
Institut für Arbeitshygiene der Medizinischen Akademie „Carl Gustav Carus" Dresden.

Stated Purpose: To determine whether the use of hearing protection aids at noise intensity over 85 dB and medium physical strain will exclude vegetative reactions.

Study Design and Sample:

: Quasi-experimental design.

: 8 clinically and otologically healthy males, 22-35 years of age; one subject's data excluded from mean value calculations because his responses were extreme.

: Three single tests on each subject, performed at same time of day with rested test persons; sequence of single tests permutated with subjects knowing the respective sequence of the tests.

: Test 1: 10 minute rest; 30 minutes of continuous exercise at 60 mkp/s; 10 minutes rest; use of ear plugs.
Test 2: 10 minute rest; 30 minutes of continuous exercise at 60 mkp/s with simultaneous influence of 90 dB wide-band noise; 10 minutes rest; use of ear plugs.
Test 3: 10 minute rest; 30 minutes of continuous exercise at 60 mkp/s with simultaneous influence of 75 dB wide-band noise; 10 minute rest; without use of ear plugs.

Data Sources : Laboratory experiment.

Bias Potential in Design:
A small group of subjects used as their own controls without an external control group may not be adequate to prevent the results from being confounded by multiple factors on which the individuals vary. As the authors indicate, knowledge of the sequence of the tests could have influenced the subjects, resulting in the higher heart rate at rest in tests 2 and 3 against test 1.

Noise Exposure:
Noise Description:
Source : Two loudspeakers (3 VA each); noise generator.
Type : Wide-band noise.
Frequency Composition: Wide-band noise.
Levels : 90 dB for test 2, probable maximum of 79 dB with hearing protection; 75 dB for test 3; 50 dB for noise level in room under quiet conditions.
Duration of Exposure: 30 minutes per test session.
Instrumentation: Not reported.

Measurement Procedures: Not reported.

Environment : Uncontrolled; thermal neutral field; room with noise floor "around 50 dB". Loudspeakers placed symmetrically on the sides of subjects. Subjects in diffuse sound field so that head movement did not influence noise level.

Subjects : Reported to be otologically and clinically healthy, but no information provided as to history of ear disease or hearing thresholds. History of vocational and avocational noise exposures not given.

Evaluation : Noise was well described in this laboratory-type controlled study. However, the noise measurement or calibration procedure and subject's history of noise exposure were not reported.

Health Effects:

CVS Response : Heart rate, oxygen consumption and carbon dioxide output. Instrumentation described.

Evaluation : Study conducted under well controlled situation. Conclusion that attenuation does not affect cardiovascular response may not be valid since degree of attenuation was not actually documented.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively.

Statistical Methods: t-test, F-test.

Control for Potential Confounders:

Design intended to control for confounders (see Bias Potential in Design). No information given as to vocational and non-vocational exposures of the subjects prior to and between testing sessions.

Conclusions:

Authors : The use of ear protectors does not prevent the influence of 90 dB wide-band noise upon the heart-circulatory system. The role that body-sound conduction or other physiological processes play needs to be explained through further research.

Overall Evaluation:

This innovative study, using the stress of exercise to enhance response, could be improved with adequate controls and blood pressure monitoring. It is unfortunate that Quaas and colleagues were not able to use a 90 dB without ear plugs situation in an additional test series. The study is of interest because it suggests acute heart rate effects of noise in individuals with properly worn ear protectors even though the actual attenuation could only be estimated. It is not clear how comparable the ear protectors used in the study are to the fairly well designed ear plugs or ear muffs available in the U.S.

(Scores on a scale of 0-9)

Noise Exposure = 6
Health Effects = 9
Epidemiologic Method = 5

Citation: Rumiantsev, G.I., Mekhelson, D.A. and Sechenov, I.M.: Effect on Sailors of the Noise-Vibration Factor in the Complex of Conditions Prevailing on Ships. Gigiena I. Sanitariia 36(9):25-27, September, 1971. (Russian)

Researchers and Institution where research performed:
1st Moscow Medical Institute, Scientific Research Institute for Water Transportation Hygiene.

Stated Purpose: To study the influence of vibration and noise in ship conditions on some aspects of metabolism in sailors; to review the effectiveness of the complementary administration of thiamin and nicotinic acid in noise-vibration exposure.

Study Design and Sample:

: Occupational group of sailors on 8 ships: 2 floating bases, 3 cargo ships, 2 passenger and freight ships and 1 tanker.

: Cross-sectional study with investigations conducted before the voyage, on the 15th and 30th days of the course; arterial pressure and pulse were tested in the engine squad crew members before and after each watch.

: 86 sailors, aged 25-35 years with not less than 3 years employment were grouped as follows:
Group 1 - sailors in the engine section;
Group 2 - sailors of the engine room given 5 mg. of thiamin and 50 mg. of nicotinic acid per person;
Group 3 - sailors on the deck squad who served as controls.

: Sampling frame, determination of sample size and sample selection were not described.

Data Sources : From tests conducted during the study period.

Bias Potential in Design:
Self-selection bias; bias due to lack of comparability of groups on multiple factors such as diet while off-ship, exercise, previous noise exposures, hearing sensitivity; non-response bias likely if data in tables represent subjects participating in every test.

Noise Exposure:
Noise Description:
Source : High speed engines.
Type : Ship engine noise; steady.
Frequency Composition: Group 1(engine squad): low and medium frequencies; Group 2 (engine squad on Vit. B_1 and nicotinic acid): low and medium frequencies; Group 3 (deck squad) controls.
Levels : Actual levels not reported. Reported "noise produced by the operation of engines and other power equipment, in high frequency bands of the spectrum, exceeded maximum permissible levels by 10-15 dB on the average." Permissible levels not defined. "On deck, on platform between engines, at switchboard of turbo- and gas generators, and the boiler room of the engine room, levels of vibro-speed exceeded

maximum permissible values for average geometric frequencies of 16, 32, and 65 Hz by 18-25, 17-22, and 13-16 dB respectively." Description of noise for control group is questionable.

Duration of Exposure: Presumed on basis of years employed - no subject had less than 3 years employment. Crew members on ships exposed 24 hours per day. Duration of voyages not reported.

Instrumentation: B & K equipment used; type, model and compliance was not reported, but B & K is quality equipment.

Measurement Procedure: Not reported.

Environment : Uncontrolled; relationship of subjects to noise sources not described.

Subjects : Employed not less than 3 years; no other vocational exposures given; history of avocational exposures not reported. No information provided for history of ear disease and hearing thresholds.

Evaluation : Actual noise spectra were not reported. Subject information, duration of actual exposures, and type of instrumentation and procedure for measuring noise were not provided the reader. Noise environments relative to the working position of subjects and the noise exposure condition of the control group (deck squad) need further clarification.

Health Effects:

CVS Response : Cholesterol in blood serum (Mrskos and Tovarek Method); gamma-globulin level (turbidimetric method); blood pressure; and blood sugar (colorimetric method). Blood pressure taken on engine squad only, before and after each watch. No information on data collection procedures and quality control.

Evaluation : Difficult to evaluate blood pressure changes since "controls" were not tested and no data were reported. Information as to time of day and conditions under which tests were taken are not provided. No indication as to whether or not blood sugar was a fasting value. Multiple potential confounding factors such as humidity, temperature, activity, make interpretation of changes in blood sugar and lipoproteins questionable.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: p-values given but no information on analysis or statistical tests.

Control for Potential Confounders:

No evidence of control of any confounders such as age, previous noise exposure, humidity, temperature, diet, weight, smoking, diabetes depending upon health measure under analysis.

Conclusions:

Authors : "The analysis of the material obtained makes it to a certain degree possible to differentiate changes related to the effect of noise and vibration from the possible effect of

other factors. Thus, significant increase of the sugar concentration in the blood on the 15th day of the course and of β-lipoproteins in the blood serum on the 30th day of the course in sailors of the 1st group, with no analogous shifts (during the same period) in persons of the 3rd group, can probably be treated as the consequence of noise-vibration effect. The changes of the arterial pressure and pulse before and after the watch in the sailors of the 1st group can be explained in the same manner."...
"Since the daily additional administration of the vitamins B_1 and PP to the sailors of the 3rd group prevented them from developing changes in the studied indexes of metabolism, we can evaluate the use of thiamin and nicotinic acid as a protective measure limiting the adverse effect of vibration and noise continuously acting on sailors' organisms."

Overall Evaluation:

This was an inadequately controlled study of questionable size. Data were not adequately analyzed; there was no indication of control for confounding variables. Noise exposure of subjects need additional clarification. Overall, the study is not informative for evaluating the association between noise exposure and cardiovascular effects. We cannot concur with the authors conclusions.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 7
Epidemiologic Method = 2

Citation: Sanova, A.G.: Complex Effect of Low Frequency Noise and Infrasound on the Organism of the Worker. Vrachebnoe Delo (10):133-136, 1975. (Russian)

Researchers and Institution where research performed:
General Hygiene, Kiev Medical Institute.

Stated Purpose: To study the effect of low frequency and infrasound noise on the worker.

Study Design and Sample:

: Occupational groups - compressor operators and controls of auxillary workers in the same plant.

: Cross-sectional comparison of 144 compressor operators exposed to continuous noise and 30 controls working in the same plant in low noise conditions; males, 20-50 years of age; length of employment ≤ 1 year = 6.9% of workers; 1-5 years = 30.6%; 6-10 years = 34%; 11-20 years = 22.2% and > 20 years = 6.3% of the workers.

: No information on sample size determination, sample selection, response rate.

: Size of the control group is probably inadequate for providing stable blood pressure means.

Data Sources : Not stated; implied primary data collected for study purposes.

Bias Potential in Design:
Selection and measurement bias; sample size bias.

Noise Exposure:
Noise Description:
Source : Compressor units.
Type : Industrial; steady versus nonsteady not reported.
Frequency Composition: Actual noise spectra not reported; low frequency not defined; infrasound maximal level around 16 Hz. The intensity of noise and spectral composition of the compressor units changed depending on the number of rotations of the compressor cyclinder.
Levels : In compressor shops: 87-98 dBA noise level and 90-110 dB infrasound level.
Duration of Exposure: Presumed on basis of number of years employed (see Study Design).
Instrumentation: B & K noise meter, type 2203; B & K octave spectrum analyzer, type 1613; in compliance with ANSI or ISO standards.
Measurement Procedure: Not reported.
Environment : Uncontrolled; 7 compressor shops of various industrial enterprises; relationship of workers to noise source not described.
Subjects : History of vocational noise exposures reported by years employed; no other job exposures or avocational exposures noted. History of ear disease not reported; "tonal audiometrics" accomplished using Elza and AP-02 audiometers.

Evaluation : Duration of noise exposure based on years of employment is questionable. Frequency composition of noise was described in general rather than specific terms. Procedure for measuring noise not reported. Noise environments not described as to workers' locations relative to noise sources. Insufficient subject information.

Health Effects:

CVS Response : Arterial blood pressure, not defined; no measurement or quality control of data given.

: EKG, single channel electrocardiograph "Saliut", leads I, II, III, VI and V5.

: Contractile blood volume and one minute blood volume; derived measures with no methodology or definitions given.

: Peripheral resistance, method not defined.

: Neurological examinations and respiratory spirometry were conducted in addition to cardiovascular responses.

Evaluation : Parameters, without adequate data, introduced in results without provious mention and without stating methodology. It is not clear when and under what circumstances the data were collected. There were no exclusions for history of heart disease. The risks for cardiovascular disease of the changes observed or that these changes (e.g., contractile function of the myocardium) represent abnormalities are not known and are not documented by the author.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively. Systolic blood pressure increased more with age among workers exposed to noise than among the 30 controls.

Statistical Methods: None stated. Reports data to the effect that the hypertension rate among the noise exposure group increased and stroke volume decreased with years on the job, but no comparisons made with low noise controls.

Control for Potential Confounders:

Age controlled by stratification. No evidence of control for other variables.

Conclusions:

Author : "The analysis of the indexes of the functional state of the cardiovascular system indicated that the percentage of workers with normal blood pressure decreases the longer the length of employment in compressor shops."..."In the basic group [noise], we observed the increase of systolic pressure to be more pronounced in relation to age [than in workers not exposed to noise]."..."The reduction of the contractile function of the myocardium, increasing with the length of employment in the compressor shop, can be related to the disorder of the functional state of the myocardium under exposure to noise."

Overall Evaluation:

This study offers little support for the hypothesis of an association between noise exposure and high blood pressure. The control group is very small, there is inadequate control of confounding variables and inadequate analysis with very little blood pressure data provided to the reader.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 3
Epidemiologic Method = 3

Citation: Shatalov, N.N., Saitanov, A.O. and Glotova, K.V.: The State of the Cardiovascular System Under Conditions Involving Exposure to the Action of Continuous Noise. Gigiena Truda i Professional'nye Zabolevaniia 6(7):10-14, August, 1962a. (Russian)

Researchers and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases of U.S.S.R. Academy of Medical Sciences.

Stated Purpose: To study the condition of the cardiovascular system in persons working in conditions of industrial noise because of the great theoretical and practical importance of the problem.

Study Design and Sample:

: Occupational groups from a ball bearing shop and twisting shop.

: Cross-sectional comparison of workers under two relatively high noise levels with health measures taken before and after work and during the course of the work day.

: 300 subjects: 80? men and 120 women; 225 were younger than 40 years of age and 143 had worked in noise 10 years or more.

: 156 workers of a twisting plant exposed to 85-95 dB noise and 144 workers of a ball bearing plant exposed to 114-120 dB noise.

: The sample is of questionable size; no information provided on sampling method, response rate, exclusions due to health conditions.

Data Sources : Noise data collected by Institute Hygiene Section; health data apparently collected for study purposes.

Bias Potential in Design:
Self-selection and sampling bias (especially in view of even number observed); measurement bias.

Noise Exposure:
Noise Description:
Source : Not reported, only gave work locations: twisting shop of synthetic fiber combine and ball bearing shop.
Type : Industrial noise, continuous.
Frequency Composition: Mixed in both shops; mostly medium and high frequencies (400, 600, 1600 and 6400 Hz).
Levels : Twisting shop: 85-95 dB; ballbearing shop: 114-120 dB.
Duration of Exposure: Not reported; only stated that 143 persons had worked 10 or more years in noise.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled, not described.
Subjects : History of vocational noise exposures described in general with no individual subject data; no other work exposures reported; history of avocational noise exposure, history of ear disease, and hearing thresholds not stated.

Evaluation : Sources of noise and durations of exposures to noise not reported. Instrumentation, procedures for measuring noise and the worker's relationship to noise sources in the environment were not described.

Health Effects:

CVS Response : Blood pressure with the Riva-Rocci apparatus by the Korotkov method; high blood pressure was defined as > 130/90 for persons younger than 40 years and > 140/90 for persons older than 40 years. Low blood pressure was defined as < 100/60 mm Hg. for all persons.

: Oscillography, electrocardiography and ballistocardiography.

: No information provided as to measurement procedures, quality control of the data or definitions of "abnormal" results other than for blood pressure.

Evaluation : Blood pressure was said to be elevated after physical stress, but physical stress is not described. The sinus bradycardia detected is not an abnormality. EKG changes recorded are non-specific and intraventricular conduction (QRS duration?) measurements are of unknown clinical significance.

: Authors state that data failed to confirm a hypertensive effect of noise. It is unclear what, if any, arterial blood pressure comparisons were made and which of the multiple readings were used; adequacy of comparison group, especially in evaluating blood pressure, must be questioned.

: The results indicated sinus bradycardia and lability of the arterial pressure, non-specific T-wave changes with only bradycardia and T-wave changes greater after work in the higher noise group.

Judging Causal Significance:

Strength of the Association: States that no hypertonic effect of noise was observed.

Statistical Methods: No statistical tests given; no mean blood pressures nor distributions of blood pressure reported.

Control for Potential Confounders:

No evidence of control for major confounding variables for hypertension, age and sex and for comorbidities which apparently were present in the groups studied. Since an equal distribution of men and women in the twisting and ball bearing shops is highly unlikely and the distribution of workers employed 10 or more years is unknown, failure to control for age and sex may result in spurious conclusions.

Conclusions:

Authors : "Very often the workers examined had labile arterial pressure. According to the electrocardiographic data, bradycardia with a tendency toward retardation of the intraventricular conductivity and the falling off of the T-wave were observed, which were more common after physical stress and at the end of the work day. In the group of workers exposed to the effect of noise of greater intensity, functional changes in the cardiovascular system were more common and more pronounced." The hypertensive effect of noise reported in the literature was not observed in this study.

Overall Evaluation:

The cross-sectional study design, comparison of groups with relatively high noise levels and no low noise level control, selection bias and the strong possibility of confounding from failure to statistically control for age and sex differences, severely limits the usefulness of these data in drawing inferences as to the association of noise and cardiovascular effects. The sinus bradycardia reported was judged not to be an abnormality and the T-wave changes in high noise are non-specific and of questionable clinical significance.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 3
Epidemiologic Method = 3

Citation: Shatalov, N.N.: Some Hemodynamic Shifts Resulting From the Effect of Industrial Noise. Gigiena Truda i Professional'nye Zabolevaniia 9:3-7, June, 1965b. (Russian)

Researchers and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases, U.S.S.R. Academy of Medical Sciences.

Stated Purpose: "Considering the possibility of the adaptation of man to noise, we found it useful to compare (while studying its influence on the state of the cardiovascular system) hemodynamic indicators in persons exposed to continuous and intermittent noise in the course of a work day."

Study Design and Sample:
: Occupational groups not specified.
: Cross-sectional data from several groups of workers exposed to continuous noise and to intermittent noise.
: No control group of subjects exposed to low noise levels; reference made to workers of other industrial enterprises.
: Of 589 workers studied for hemodynamic indicators, 368 worked in continuous noise and 221 in periodic or intermittent noise.
: Of 1357 persons studied for blood pressure effects, 1019 were exposed to continuous noise and 338 to intermittent noise.
: Individuals with history of cardiovascular disease were excluded.
: No information given on sampling frame, how group members were selected nor response rate.

Data Sources : Not stated.

Bias Potential in Design:
Selection bias (self-selection, selective survival, selective recall) very probable. Measurement bias highly likely in study of such a large number of people since data probably collected over time by plant physicians.

Noise Exposure:
Noise Description:
Source : Not reported.
Type : Industrial, continuous and intermittent noise.
Frequency Composition: Measurement findings not reported. Groups 1 and 2: wide band spectrum with high frequency domination.
Levels : Group 1: 85-95, 114-120, 105-122 dB (very confusing as to which subjects in this group were exposed to which levels). Group 2: 85-111 dB
Duration of Exposure: Group 1: exposed to continuous noise during the whole work day. Group 2 exposed in the course of the work day to periodic noise. Groups 1 and 2 not differentiated by length of employment: 23.5% employed approximately 5 years, 24% from 5-10 years and 52.5% for more than 10 years.

Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; not described.

Subjects : Vocational exposures for the various groups unclear; total vocational exposures not reported. No information provided on history of avocational noise exposure, history of ear disease or hearing thresholds of subjects. Although "mobility of hearing organ" was discussed, there was no definition as to the meaning of mobility.

Evaluation : Noise description information is very poor. Noise sources, instrumentation and procedures for measuring noise, source and subject relationship in noise environment were not described. Presentation of information leaves the reader very confused regarding the actual noise levels at which subjects were exposed.

Health Effects:

CVS Response : Blood pressure taken at the beginning of the day, after a ten minute rest. No diagnostic criteria or measurement procedures stated. Increased blood pressure defined as > 130/90 mm Hg. for persons < 40 years of age and > 140/90 mm Hg. for workers > 40 years of age. Low blood pressure defined as < 100/60 mm Hg. Other hemodynamic indicators were detailed, but not defined: ECG, ballistocardiography, phonocardiography, peripheral resistance, venous pressure, heart size (clinically) and auscultation of heart.

Evaluation : Study contains numerous poorly documented cardiovascular parameters. Only blood pressure criteria were defined for differentiating increased and decreased values. Methods for determining and measurement procedures not given for pulse wave propagation rate, capillary pulse, venous pressure and peripheral resistance. The value of venous pressure to health is not known. Failed to state whether the contractile function assessed by phonocardiography was corrected for rate since an increase in systolic time intervals is observed in slow rates. EKG abnormalities were not defined.

No raw data are provided the reader. It appears that there was an increase in blood pressure in the periodic noise group and an increase in pulse rate. The frequency of increase in pulse rate in total population studied was not stated. The data are so poor, the cardiovascular effects cannot be adequately evaluated.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Not stated; very little data presented.

Control for Potential Confounders:

No evidence of statistically controlling for potential confounders such as age, sex. Individuals with history of cardiovascular disease were excluded.

Conclusions:

Author : "Very often the workers in 'noisy' occupations have complaints of a cardiac character; their arterial pressure is changed. In persons exposed to continuous noise, first of all the symptoms of vascular dysfunction are observed (lability of the arterial pressure, tendency toward the reduction of venous pressure and the reduction of peripheral resistance, bradycardia). Under exposure to intermittent noise in the course of a work day a clear tendency to hypertension is present (rising arterial blood pressure, increased rapidity of dispersion of the pulse wave in the elastic vessel, the symptoms of capillary spasm more common)."

Overall Evaluation:

This study contributes little, if anything, to the understanding of the relationship of noise exposure to cardiovascular disease. The clinical significance of some of the measures are questionable. More importantly, the total subject pool and the respective noise exposures of the groups are very unclear, the methodologies and measurement procedures for the cardiovascular responses are not described adequately, there is no evidence of controlling for confounding variables and insufficient data are presented to support the author's conclusions.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 3
Epidemiologic Method = 2

Citation: Shatalov, N.N., Ostapkovich, V.E. and Ponomareva, N.I.: Hearing and Arterial Tension Under the Effects of Intensive Industrial Noise. Gigiena Truda i Professional'nye Zabolevaniia 13(4):2-15, April, 1969c. (Russian)

Researchers and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases of U.S.S.R. Academy of Medical Sciences.

Stated Purpose: To compare the state of the hearing with indices of arterial pressure.

Study Design and Sample:
: Occupational groups of a ball bearing plant, mechanical plant and synthetic fiber production plant.
: Cross-sectional study.
: 806 persons exposed to intense (90-122 dB) broad band noise with predominant high frequencies compared to a control group of 210 men and women of the respective ages with normal hearing, not exposed to industrial factors influencing the cardiovascular system and hearing organs.
: No information on selection of subjects, non-response; unclear as to selection of the control group and their comparability with noise exposed individuals on general work conditions, social class, work stress, etc.

Data Sources : Not specified.

Bias Potential in Design:
Selection bias, nonrespondent and measurement bias. The fact that no severe hearing loss was reported among the workers in the noise exposed group suggests that selective forces may have been removing the severely hearing impaired from these work areas.

Noise Exposure:
Noise Description:
Source : Not reported; subjects worked in ball and roller bearing sections of a ball bearing plant; needle section of a mechanical plant and twisting section of a combine for synthetic fiber production.
Type : Industrial; not reported whether steady, nonsteady or impact.
Frequency Composition: Not reported for each work condition; general description: broad band noise with high frequencies predominating.
Levels : General level 90-122 dB; levels for each job not reported.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; not described.
Subjects : Only current jobs of the exposed considered; vocations of controls were not described. No history of avocational noise exposures nor history of ear disease. Hearing

thresholds obtained and subjects categorized according to slight, moderate and severe hearing loss. Slight loss: increase of hearing threshold at high sound frequencies (4000 Hz or more) of up to 50 dB, and increase of threshold in range of speech frequencies (500-2000 Hz) of up to 25 dB; moderate loss: increase of hearing threshold at high frequencies to 50 dB +, at speech frequencies to 25-35 dB; severe loss: increase of the hearing threshold at high frequencies greater than 50 dB and at speech frequencies greater than 35 dB.

Evaluation : Poor effort regarding reporting of noise parameters. Instrumentation and procedure for measuring noise not reported. Noise sources not identified. Subjects positions in environment relative to noise sources not described.

Health Effects:

CVS Response : Blood pressure readings taken in the morning before the beginning of work. No information provided as to criteria, methods of measurement of blood pressure nor of treatment for hypertensive disease.

Evaluation : Insufficient information provided to adequately evaluate health measures. There appears to be a blood pressure difference, but this may not represent a real difference since the comparability of the control group is very unclear.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Means, standard deviations and t-values.

Control for Potential Confounders:

Partial control for age by stratification into groups > 40 years and < 40 years old. No evidence of control for or consideration of obesity, job stress other than noise, co-morbidities.

Conclusions:

Authors : "The comparison of the state of hearing and arterial pressure in persons working in conditions of the effect of intense industrial noise showed that the changes of the arterial pressure precede hearing damage. Therefore, one cannot exclude the role of vascular disorders in the development of occupational hearing impairment. In those cases when hearing is already lowered there is no further progression of the processes of sharp dependence on the state of the arterial pressure."

Overall Evaluation:

The study is poor for judging the association between noise exposure and blood pressure changes. Major weaknesses included inadequate information on the assemblage of the exposed and control groups, too few control subjects, insufficient information on sound and blood pressure measurement and incomplete control of confounding variables.

It is difficult to determine to what extent the study may suffer from selection bias due to removal from the work force individuals experiencing both severe hearing loss and hypertension.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 2
Epidemiologic Method = 2

Citation: Shatalov, N.N. and Murov, M.A.: The Influence of Intensive Noise and Neuropsychic Tension on the Level of Arterial Pressure and the Incidence of Hypertensive Vascular Disease. Klinicheskaia Meditsina 48:70-73, March, 1970d. (Russian)

Researchers and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases of U.S.S.R. Academy of Medical Sciences.

Stated Purpose: To study the level of arterial pressure and the incidence of hypertensive disease in workers in the so-called noisy occupations.

Study Design and Sample:

: Occupational groups: fitters and lathe operators, operator-testers of cranes, scientists and laboratory workers.

: Cross-sectional study.

: 2034 men and 1896 women, 62.4% between 20-39 years old, grouped by noise exposures as follows:
Group 1: 1275 fitters, loaders, lathe operators exposed to broad band noise at 95-112 dB in which spectrum high frequencies dominate;
Group 2: 339 operator-testers of cranes with noise analogous to Group 1 and with neuropsychic tension;
Group 3: 1172 scientists with mental work associated with neuropsychic tension (no noise implied, but not stated).
Group 4: 1144 technicians and skilled mechanics in work not connected with noise nor neuropsychic tension - control group.

: No information provided as to total number of potential subjects, determination of sample size, sample exclusions and/or nonresponse.

Data Sources : Not specified.

Bias Potential in Design:
Selection bias, selective survival is likely with varying degrees of bias across groups. Comparability of scientists and technician control groups on characteristics other than noise (and age and sex which are controlled) is not likely; although authors use the word "incidence", the data are prevalence data from which accurate temporal relationships between noise and blood pressure can not be derived.

Noise Exposure:
Noise Description:
Source : Not reported; occupations stated (see Study Design).
Type : Industrial noise; steady or impulse noise not stated.
Frequency Composition: Group 1: broad-band noise with high frequencies dominating; Group 2: noise analagous to Group 1 with tension; Groups 3 and 4: noise parameter not described, but considered "no noise" or controls.
Levels : Groups 1 and 2: 95-112 dB; Groups 3 and 4: not reported.
Duration of Exposure: Not reported.

Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; not described.
Subjects : History of vocational noise exposures, avocational exposures, history of ear diseases, and hearing thresholds not reported.
Evaluation : Noise parameters are so poorly reported it is difficult to determine precisely how groups may vary. Sources of noise appear to be multiple and are not identified. Instrumentation and procedures for measuring noise, subject information and duration of exposure are not reported. The noise environments are not described.

Health Effects:

CVS Response : Systolic and diastolic blood pressures and hypertension. No diagnostic criteria or definition of hypertension provided. No information available as to how blood pressure was taken, when or by whom or of medications taken by subjects.
Evaluation : Variability in blood pressure assessment methods, etc. and lack of comparability of controls to other groups on activity level plus other unknown confounding factors may account for the differences observed.

Judging Causal Significance:

Strength of the Association: Not stated quantitatively, but tabled data show an age-sex adjusted prevalence rate of hypertension among men exposed to the combined effects of tension and noise to be 13.57 compared to 3.95 for the controls, for a prevalence ratio of 3.4. These differences reported to be statistically significant. No other comparisons among the groups were significant. Mean differences in systolic and diastolic blood pressures between the noise plus tension group (2) and the control group (4) were 9.3 mm Hg. and 6.9 mm Hg. respectively.

Statistical Methods: Means and standard deviations of systolic and diastolic blood pressures; t-tests. Multiple t-tests comparing each group with the control (group 4) and with each other performed. More efficient methods for handling multiple groups and controlling for age-sex might have been used to advantage.

Control for Potential Confounders:

Age and sex were controlled in the analysis with stratification and standardization procedures. Other potential confounders for hypertension such as obesity, family history, exercise, smoking history and diabetes were not considered. No information was provided relative to hearing thresholds or duration of employment (exposure).

Conclusions:

Authors : "The studies conducted show that the exposure to industrial noise causes an increase of systolic pressure (in the age groups below 40 years) and a rise of incidence of hypertensive disease, compared to the control. Given the intensity of the effect on the incidence of hypertensive disease, exposure to noise as an industrial factor is sufficient cause for neuropsychic tension. The combined effect of the two industrial factors mentioned increases the number of pressure reactions to an even greater degree, in connection with which the incidence of hypertensive disease is significantly augmented."

Overall Evaluation:

This study treats prevalence (at best) data as incidence, describes noise exposure groups in general terms only, and reports no definitions, diagnostic criteria or measurement procedures for blood pressure data. The large number of subjects and variety of jobs within noise exposure groups suggest there is great potential for confounding of the effects by unknown factors. There was incomplete controlling of confounding variables and rather simple analysis, given the data available. Although the authors infer that noise adversely influences blood pressure, the reviewers judge the study to be too poor to warrant this inference.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 1
Epidemiologic Method = 4

Citation: Stasiow, A., Guzikowska, H. and Guzikowski, J.: Selected Studies of the Circulatory System After Exposure to Industrial Noise. Polski Tygodnik Lekarski 29(44):1901-1904, November, 1974. (Polish)

Researchers and Institution where research performed:
The Voivodeship Mining Ambulatorium in Katowice.

Stated Purpose: In order to show how some parameters of the circulatory system in humans after exposure to industrial noise behave, workers in a mechanical coal-processing section of a mine were studied.

Study Design and Sample:

: Occupational group - workers in the washers, a section of the mechanical coal processing section of a mine.

: Cross-sectional data with measures taken before work and after 7.5 hours exposure to noise; no control group.

: 31 workers, ages 35-62 years, employed in mine more than 6 years; individual noise protectors were not used.

: Observations made in April and May; dust content was within maximum permissible concentrations; job required little energy expenditure (1000-1500 cal.); machines caused a small degree of vibration.

: No information provided on sample selection, sample size determination, nor consideration of self-selection of sensitive hyperreactors.

Data Sources : Primary data collected for purposes of this study.

Bias Potential in Design:
Selection, expecially self-selection bias; interaction of selection and exposure to noise; regression to the mean.

Noise Exposure:

Noise Description:

Source : Not reported; from mechanical coal processing machines.

Type : Industrial; whether steady or nonsteady, not reported.

Frequency Composition: 250, 500, 1000, 2000 and 4000 Hz dominated the noise spectrum.

Levels : Ranged from 86-102 dB

Duration of Exposure: A day's work or 7.5 hours of exposure to noise between the measurements; individual exposures to noise on the job not reported - length of employment more than 6 years.

Instrumentation: "Sonometer" with an octave filter and a capacitive microphone, Bruel & Kjaer equipment which usually meets standard requirements.

Measurement Procedure: Microphone placed at a height of 1.5 meters above the floor, and in the case of measurements at a work place, in a position near the head of the worker. Whether multiple measures were made and whether multiple microphone positions were used was not reported. Compliance is not stated, but is presumed since height of the microphone position is in compliance with AASI Standard 1.13-1971 (R1976).

Environment : Uncontrolled; mechanical coal processing section of a mine, not further described. Although noise measures were made in a position near the head of the worker, this does not describe the relationship between the noise source and the worker, nor the working environment.

Subjects : Individual noise exposures on the job not described; all had worked in mine for more than 6 years; work exposures to jobs other than present job not reported. No information on history of avocational noise exposure, history of ear disease and hearing thresholds before and after the noise exposure.

Evaluation : Actual duration of exposure to noise is questionable; noise sources, subject information and relative positions of workers and noise sources in the environment were not described.

Health Effects:

CVS Response : Arterial blood pressure measured in a sitting position with a mercury sphygmomanometer, after a night's rest before work and repeated after 7.5 hours of exposure to noise. A difference of 5 mm Hg. was judged to be a fall or rise in blood pressure.

: A cooling test according to Hines and Brown to test the arterial pressure at 30 and 60 seconds of cooling and 60 sec. after cooling checked, taking the highest value.

: EKG at rest with 12 standard leads and evaluated according to the Minnesota Code.

: Width of arterioles by retinography (eye ground photos).

Evaluation : No information as to quality control of the measurements; assumed a single blood pressure reading was taken. Without background knowledge of the health status of each subject, it is difficult to determine the clinical significance of the EKG changes. No control group, but conclusions about blood pressure shifts during the work day (especially diastolic) appear appropriate.

Judging Causal Significance:

Strength of the Association: Not stated.

Statistical Methods: Test for signs at the $\alpha = .05$ level.

Control for Potential Confounders:

No evidence of control for any variables. One-group before-after design is weak in controlling for confounding extraneous variables.

Conclusions:

Authors : "1. In the examined group of workers, under the influence of exposure to industrial noise, a significant increase in the diastolic pressure and a spastic state of the arterial vessels on the periphery were confirmed.

2. It was shown that exposure to industrial noise causes an increased vessel reactivity.

3. The observed changes in the EKG curve can speak for the domination of the parasympathetic system.

4. The changes noted in the circulatory system support the usefulness of carrying out similar studies under chronic exposure to industrial noise."

Overall Evaluation:

This investigation of the cardiovascular responses to a one day exposure to noise in a group of workers routinely exposed to noisy environments, provides insufficient information for inferring to long term noise effects.

(Scores on a scale of 0-9)

Noise Exposure = 4
Health Effects = 7
Epidemiologic Method = 3

Citation: Suvorov, G.A., Denisov, E.I., Ovakimov, V.G. and Tavtin, IU.K.: Correlations Between Hearing Losses and Neurovascular Impairments in Workers in Relation to Noise Level. Gigiena Truda i Professional'nye Zabolevaniia 0(7):18-22, July, 1979. (Russian)

Researchers and Institution where research performed:
Institute of Occupational Hygiene and Occupational Diseases of the USSR Academy of Medical Sciences; 6th Clinical Hospital of the USSR Ministry of Health Protection.

Stated Purpose: To establish qualitative-quantitative relationships between hearing losses and neurovascular impairments in workers exposed to noise which are necessary for differential noise regulation and the prevention against its effect on the organism.

Study Design and Sample:

: Occupational: 5 groups of workers in machine building industry.

: Cross-sectional study with workers categorized by degree of noise exposure: Group 1: 121 employees of construction office with noise level averaging 70 dBA (control condition); Groups 2-5 noise exposure: Group 2: 139 turners with noise 93 dBA; Group 3: 168 cutters with noise 93 dBA; Group 4: 267 motor mechanics with noise level of 100 dBA; and Group 5: 166 punchers with noise level 115 dBA.

: 587 males and 274 females studied; average age 34-38 years and average length of employment 11-16 years.

: No information provided on sample selection or response rate.

Date Sources : Extant records and periodic medical examinations between 1969 and 1970.

Bias Potential in Design:
Selection including healthy worker effect; non-response bias. Antecedent-consequence relationships unclear with prevalence data.

Noise Exposure:
Noise Description:
Source : Not reported; occupations listed.
Type : Industrial (machine building), not reported whether steady or nonsteady.
Frequency Composition: Not reported.
Levels : Group 1 - 70 dBA average
Group 2 - 84 dBA
Group 3 - 93 dBA
Group 4 - 100 dBA
Group 5 - 115 dBA
Duration of Exposure: Average length of employment for each group shown with ranges from 11-16 years. Duration of specific exposure not available.
Instrumentation: Not reported.

Measurement Procedure: Not reported, but method in compliance with USSR Standard GOST 20445-75 regarding Building and Structures of Industrial Enterprises: Methods of Noise Measurements at Workplaces.

Environment : Uncontrolled, not described.

Subjects : Average length of employment in machine building 11-16 years; other work exposures to noise not reported. History of avocational noise exposure and history of ear disease not reported. Periodic medical examinations by otolaryngologist. Threshold tonal audiometrics with an A-62M audiometer.

Evaluation : Noise sources, frequency composition of noise, instrumentation for measuring noise not reported. Actual durations of exposure questionable. Noise environment not described. History of avocational exposure not reported, nor were other work exposures.

Health Effects:

CVS Response : Blood pressure: hypertension defined as > 140/90 mm Hg., hypertension disease as 159/94 mm Hg. and hypotension as < 100/60 mm Hg. Hypertonic neurocirculatory asthenia presumed to be neurocirculatory asthenia plus hypertension, not defined. Atherosclerotic cardiosclerosis not defined. Data collected by specialists at periodic medical examination.

Evaluation : No measurement procedures, quality control of data or diagnostic criteria stated. Apparently standard criteria for defining blood pressure were used. It is likely that therapists were aware of noise exposure status of workers. Differences in physical activity requirements of work may explain some of the differences between Group 1 (low exposure) and the other groups.

Judging Causal Significance:

Strength of the Association: With an increase in the level of noise of 1 dBA, the neurovascular impairment increases by 0.5%. "The same frequency of neurocirculatory impairment can be observed in proportion to the increasing level of noise in cases of shorter length of employment, which confirms the occurrence of the dose-response relationship." The rate of hypertension disease in workers of noisy professions, although higher than in the low noise group was not significantly high in any of the groups.

Statistical Methods: Regression analysis.

Control for Potential Confounders:

Incomplete control of age with length of employment. No evidence of controlling for sex, weight, history of disease.

Conclusions:

Authors : "...At low noise levels, neurovascular disorders prevail, while hearing losses prevail at high levels. Qualitative and quantitative dose-response relationships were established in respect to both the hearing function and mediated responses: the rate of increase in hearing and neurovascular impairments depended on the level of noise, and was 1.5% and 0.5%

respectively, per 1 dBA of increase in the noise level; the increased noise level accelerates the sumptoms of nonspecific mediated impairments (on the average by 13 years with the noise level increased by 31 dBA), most of which belong to hypertonic states."

Overall Evaluation:

This fairly well designed cross-sectional study of workers in the machine building industry provides some evidence of a positive and dose-response relationship between noise exposure and neurocirculatory impairment. The evidence is weaker for indicating an adverse relationship between blood pressure and noise although there is such a trend in the data. The principle methodological concern is the incomplete control of confounding variables such as sex, age, and weight. It would have been more informative had the authors reported blood pressure levels of the groups rather than proportion of hypertensives. However, without knowing the distribution of ages around the mean, it is difficult to determine if proportion hypertensive is an adequate way to examine the data.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 5
Epidemiologic Method = 5

Citation: Tavtin, IU.L.: Clinico-Audiological Parallels Between the State of the Acoustic Analyzer and Functional Disorders of the Nervous and Cardiovascular System in Workers Occupationally Exposed to the Effects of Noise of Various Parameter. *Gigiena Truda i Professional'nye Zabolevaniia* (4):21-24, 1976. (Russian)

Researchers and Institution where research performed:
Not specified.

Stated Purpose: To determine the amount and level of industrial noise at which such complexes of disorders can be observed, in workers of a machine-building plant.

Study Design and Sample:

: Occupational groups from a machine-building plant exposed to various levels of noise.
: Cross-sectional data.
: Group 1: 121 from the design office with general noise levels = 70 dB; Group 2: 139 from the lathe shop with noise level = 83 dB; Group 3: 168 from the mechanical shop with noise level = 94 dB; Group 4: 267 from engine testing stations with noise levels = 110 dB; Group 5: 166 blacksmiths and stamp operators with noise levels = 114 dB.
: Groups included 281 women and 580 men; sex not specified by noise group.
: Total workers categorized by length of employment as < 5 years, from 5-9 years, 10-14 years, 15-19 years, > 20 years.
: No information provided about sample selection or exclusions from the study.

Data Sources : Not specified.

Bias Potential in Design:
Selection; "impure" noise exposure groups based on general levels; small control group (Group 1).

Noise Exposure:
Noise Description:
Source : Group 1: low level office noise;
Group 2: lathes, fitters, polishers and sharpeners;
Group 3: fitters, milling machines, drills and repair equipment;
Group 4: engines and cranes;
Group 5: forging machines no. 1 & 2.
Sources intermixed with occupations
Type : Industrial, stable (steady) and pulsed (nonsteady).
Frequency Composision: Group 1: wide band (maximum in low and medium frequencies);
Group 2: wide band (maximum at 125, 250, 500 and 1000 Hz);
Group 3: 250,500 and 1000 Hz, congruent with PS-80 curve (maximum at 2000 and 4000 Hz);

Group 4: Medium to high frequencies dominate (from 500 to 2000 Hz)
Group 5: 15 to 60 impulses per minute (maximum at 250, 500, 2000, 4000 and 8000 Hz).

Levels : Group 1: general noise level = 70 dB;
Group 2: 83 dB;
Group 3: 94 dB;
Group 4: 110 dB;
Group 5: 114 dB.

Duration of Exposure: Groups 1, 2, 3 = 8 hours; Group 4 had 6 hour workday with 100-150 minutes in test chamber at most per day; Group 5: length of workday not reported; however 15-60 impulses per minute occurred.
: workers also categorized by length of employment.

Instrumentation: Not reported.

Measurement Procedure: Not described.

Environment : Uncontrolled; not described.

Subjects : Work exposures other than those in machine-building plant not reported; history of avocational noise exposures and history of ear disease not reported. Threshold tone audiometry conducted using audiometers AUG-64 to A-62M.

Evaluation : Good noise description provided, although actual durations of exposure are questionable. Instrumentation and procedures for measuring noise were not reported. Noise environment not described and very little subject information provided.

Health Effects:

CVS Response : Examinations by internist, ENT specialist and neuropathologist with diagnoses of functional disorders of the cardiovascular and nervous system, hypertonic disease (hypertension) duodenal and stomach ulcerations, chronic gastritis, and arteriosclerotic heart disease.

Evaluation : No diagnostic criteria, definitions or measurement procedure information provided. Data insufficient to evaluate the quality of the cardiovascular measure.

Judging Causal Significance:

Strength of the Association: Not stated. Data for the low noise group not described.

Statistical Methods: None stated.

Control for Potential Confounders:

No evidence that age, sex, length of employment or any other variables were considered in the analysis.

Conclusions:

Authors : "In the workers of the fifth group, pulsed noise of a general 114 dB level was the most adverse for the hearing function." "...Among functional disorders of the cardiovascular system, neurocirculatory dystonia dominated, according to the internist's conclusions. In the patients suffering from neurocirculatory dystonia the suppression of the heart tone with normal electrocardiogram, bradycardia, and drops of arterial pressure were observed." "...Under exposure to continuous noise of 110 dB...significant increase of the functional disorders of the nervous (12.5%) and cardiovascular (6.3%) systems was observed. In the exposure to a pulsed noise level of 114 dB,...functional disorders of the nervous system in 16.2%, functional disorders of the cardiovascular system in 8.4% of the cases." "...A significant increase of functional disorders of the nervous and cardiovascular systems take place under exposure to noise of a general level of 110 dB when additional neuro-emotional factors exist, and under exposure to pulsed noise of 114 dB."

Overall Evaluation:

The data presented in the publication are inadequate to support the author's conclusion of a significant increase of cardiovascular dysfunction under exposure to noise. In this cross-sectional study, the cardiovascular responses were not defined, no potential confounders such as age and sex were controlled and the observations in the high noise groups were not compared to the low noise group responses.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 0
Epidemiologic Method = 3

Citation: Terentiev, B.G., Sheludiakov, E.E. and Sviridova, E.S.: Responses to Human Nervous and Cardiovascular Systems to Aircraft Noise. Voenno-Meditsinsmin Zhurnal 6(6):55-58, July, 1969. (Russian)

Researchers and Institution where research performed:
Institution not given; USSR Aviation and Naval Medicine.

Stated Purpose: Purpose not explicitly stated; implied to study the functional as well as structural changes of the organism, affecting the ability to work and causing illness.

Study Design and Sample:
: Occupational groups of engineering and technical staffs exposed to aircraft noise.
: Cross-sectional data, collected before and after work at regular monthly intervals for an unknown period of time; anecdotal notes on several subjects to describe before-after data.
: 90 workers exposed to noise; no control subjects.
: Also included an experimental situation using 15 healthy men under laboratory conditions; no information provided on experimental conditions.
: No information on sample selection or exclusions.

Data Sources : Not described; presumed examinations were for study purposes.

Bias Potential in Design:
Selection; spurious conclusions because of impure noise exposure group with no control group and inadequate before-after analysis.

Noise Exposure:
Noise Description:
Source : Occupational-aircraft noise; laboratory not described.
Type : Aircraft noise; not reported whether steady or unsteady; laboratory noise, not reported, but presumed steady.
Frequency Composition: Not reported.
Levels : Separate conditions of 100-102, 110-112, 118-120 and 130-136 dB.
Duration of Exposure: All subjects professionally exposed to noise levels either daily or 2-3 times a week, for 1-6 hours each time. Laboratory conditions included 1 hour, 3 hour and 6 hour exposure durations.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Not described, but presumed that work environment was uncontrolled and laboratory environment was controlled.
Subjects : Engineering and technical staff had been employed for various lengths of service. No data for laboratory subjects. History of avocational noise exposures, history of ear disease and hearing thresholds not reported.

Evaluation : Source of noise in laboratory conditions not reported; aircraft noise presumed as source for subjects in vocational environment. Frequency composition of noise, instrumentation and procedure for measuring noise were not reported and noise environments were not described.

Health Effects:

CVS Response : Blood pressure, pulse rate and EKG changes at rest and after physical exercise of 15 kneebends in 20 seconds; vasomotor reflexes by plethysmography; static reflexes and coordination of cephalography; systolic volume and minute circulation derived by the formula of Starr.

Evaluation : No criteria given for the diagnostic states such as neurocirculatory asthenia, neurosis, etc. Associated diseases could explain symptoms described. It is unclear how noise effects may be separated from effects of frequent flying. Conclusions of the authors are confusing and difficult to evaluate since no data are presented to support them and no controls are used to put the findings in proper perspective.

Judging Causal Significance:

Strength of the Association: Not appropriate to study design.
Statistical Methods: None given.

Control for Potential Confounders:

No evidence of analysis of before-after measurements; no statistical controlling possible without a control group.

Conclusions:

Authors : "...we are able to conclude that a one-hour per day exposure to noise in the 110-112 dB range can be successfully endured, but that daily exposures of 3 and 6 hours will bring about harmful effects.

Research concerning reactions to noise in the range of 118-120 dB showed that the character of the changes following a single exposure is the same as described above. However, the alterations are more pronounced and the after effects persist longer. Especially severe reactions were observed during exposures lasting 3 and 6 hours." "...The frequency of heart contractions decreased by 16-17 beats a minute, maximal and minimal arterial pressure diminished, as a rule; the beat and minute volume of the heart, which were only slightly affected by exposure to noise of lesser intensity, decreased markedly upon impact of noise of the 118-120 dB level; the reaction of the cardiovascular system to physical exertion increased." ...During daily exposure of 1, 3, 6 hours of noise at 120 dB level, an increase in systolic and diastolic blood pressures were observed.

Overall Evaluation:

These anecdotal, cross-sectional and experimental findings are of little value to the study of noise effects on the cardiovascular system because of the poor study design.

No controls were employed, before-after work shift data were inadequately analyzed, confounding variables were not considered and data were not presented to support conclusions.

(Scores on a scale of 0-9)

Noise Exposure = 2
Health Effects = 1
Epidemiologic Method = 2

Citation: Troianskii, M.P., Sidortsov, I.P. and Petrova-Golubenko, L.B.: Evaluation of the Effect of Acoustic Noise on the Activeness of Cholinesterase in Blood. Voenna-Meditsinskii Zhurnal 2: 47-49, February, 1971. (Russian)

Researchers and Institution where research performed:
Institution not specified.

Stated Purpose: To study the indexes which testify not only to the presence of the effects of noise but also serve as a criterion for evaluation of the degree of their dangerousness.

Study Design and Sample:

: Occupational groups of specialists working in diesel and blower stations.

: Before-after comparison of individuals at the work site and a control group on multiple health measures.

: 55 persons studied:
Group 1 = 16 persons working 12 hours with 24 hour breaks;
Group 2 = 24 persons with 12 hour breaks;
Group 3 = 15 control group; worked in same conditions without noise.

: No information on comparability of groups by age, sex, duration of employment, environmental exposures other than noise and comorbidities.

: No information as to how subjects were selected to participate, determination of sample size, nor of how subjects were assigned to the exposure or work groups.

Data Sources : Not specified; assumed data were collected for study purposes.

Bias Potential in Design:
Selection bias; Type II error due to small sample size; non-response bias.

Noise Exposure:
Noise Description:
Source : Not reported; workers in diesel and blower stations.
Type : Industrial; whether steady or unsteady not reported.
Frequency Composition: Medium and high frequencies with maximum energy at 400-1250 Hz
Levels : In the range of 94-97 dB
Duration of Exposure: Presumed on basis of workshifts:
Group 1 worked 12 hours with 24 hour breaks;
Group 2 worked 12 hours with 12 hour breaks. It is questionable whether or not these workers were exposed to the 94-97 dB noise continuously for each 12 hour shift.
Group 3 worked in same conditions (?) without the effect of noise.
Instrumentation: Not reported.

Measurement Procedure: Not reported.

Environment : Uncontrolled; not described.

Subjects : No information on history of vocational and avocational noise exposure. Hearing thresholds and history of ear disease not reported.

Evaluation : Study is inadequate in its characterization of noise parameters. Noise sources, steady versus nonsteady state of noise, instrumentation and procedures for measuring noise were not reported. Noise environment was not described. Subject information was neglected.

Health Effects:

CVS Response : Arterial blood pressure; pulse rate; dermographia reactions; serum cholinesterase determined according to Hestrin's method.

Evaluation : No methodology, measurement procedures or quality control of the data provided other than for cholinesterase. No mid-workday testing was done on the controls, thus comparability is unknown. Authors fail to document evidence that a fall in cholinesterase has any long term pathological significance relative to cardiovascular disease.

Judging Causal Significance:

Strength of the Association: Not stated.

Dose-Response Relationship: There was a dose-response relationship noted in that there was a significant lowering of the cholinesterase with increase in hours worked. However, no data were available for complete comparison with control group. Dose-response relationship of noise to blood pressure not evident.

Statistical Methods: Means, S.D. and p-values stated. No specific tests noted. It appears that within groups but not between groups statistical comparisons were made.

Control for Potential Confounders:

Subject characteristics not stated. No evidence of any statistical controlling for variables such as age, sex, length of employment.

Conclusions:

Authors : "1. In specialists working under exposure to the effect of acoustic noise, during examinations immediately at the place of work, statistically significant lowering of the activeness of cholinesterase in blood, extension of the latent period of the dermographic reaction, and a clearer retardation of the pulse during Oschner's test, with a maximum definiteness at the end of the shift, were observed.

2. After the end of the effects of noise, the activeness of cholinesterase was restored. With 12-hour shifts, full restoration occurred after 24 hours.

3. The level of the lowering and the time of restoration of the activeness of cholinesterase can

serve as a criterion for the evaluation of the harmfulness of the effect of noise and the character of the response reaction of the organism."

Overall Evaluation:

This essentially cross-sectional study with measures taken before-during-after work provides some of the first data suggesting noise may lower cholinesterase in the blood. It utilizes a control group, but fails to take measures during the day on the controls and fails to directly compare the noise exposure data with that of the controls in the analysis. Very little information is provided regarding noise exposure and subject characteristics. There is no evidence of controlling for potentially confounding variables such as age, sex and years employed. Sample size is small and the potential for selection bias is high. Although this study is interesting it contributes very little to the understanding of the relationship between noise and cardiovascular disease.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 6
Epidemiologic Method = 4

Citation: Von Eiff, A.W. and Neus, H.: Traffic Noise and Hypertensive Risk. Munchen med. Wschr. 122(24):894-496, 1980. (German)

Researchers and Institution where research performed:
der Universitat, Bonn.

Stated Purpose: An exploratory study to determine if, by interview, more hypertension could be identified in high volume traffic noise than in low noise.

Study Design and Sample:

: Cross-sectional community survey based on "ecological" exposure to noise as opposed to individual exposures. Geographical areas of Bonn with the highest and lowest traffic levels were identified with data from the traffic noise map and on traffic countings unique to Bonn. A high noise area was defined by a noise level of 66 - 73 dB(A); a low noise area by a constant noise level of a maximum of 50 dB(A).

: 458 men and 473 women between the ages 20-59 were chosen by random sample, contacted by letter, interviewed in the home by 14 experienced interviewers. Four exclusions: residents for less than 3 years, aliens, families who had already had an interview, apartments above the second floor in noisier areas.

: 149 questions in interview with the noise questions adjusted to the Munich Study.

: Response rate: only 5 persons failed to respond.

Data Sources : Community survey; traffic maps and traffic countings.

Bias Potential in Design:
Ecologic fallacy; measurement bias.

Noise Exposure:
Noise Description:
Source : Automobiles, trucks.
Type : Automobile traffic noise.
Frequency Composition: Not reported.
Levels : High traffic area = 66-73 dB(A)
Low traffic area = maximum of 50 dB(A)
Not clear where measures were taken. Levels differ for highway or inside residences.
Duration of Exposure: Not reported.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; noisy residential area = between 9,062 and 46,643 cars 6 A.M. - 10 P.M.; quiet residential area = between 304 and 1,182 cars 7 A.M. - 7 P.M. Data obtained from Office of Town Planning, Bonn.
Subjects : No history of vocational or avocational noise exposures. Required to have lived in the residential area studied for at least 3 years. No information reported on history of ear disease or hearing thresholds.

Evaluation : Noise parameters lacking description. Authors made no measurements themselves nor did they investigate noise levels in homes versus in streets.

Health Effects:

CVS Response : Historical data from respondent on high blood pressure and previous treatment. No objective blood pressure readings obtained.

Evaluation : Excluded persons living in the area less than 3 years to assure exposure, yet related length of residence to frequency of blood pressure treatment and found an association within the high noise group but not the low. Although only historical data were obtained, data collection apparently controlled across groups.

Judging Causal Significance:

Strength of the Association: Relative to hypertension, high noise area residents more often than low noise area residents indicated existing hypertension or hypertension currently under treatment (22.8% high noise and 14.6% low noise).

Statistical Methods: p-values stated; no statistical tests given.

Control for Potential Confounders:

The groups differed on social class and smoking. Data controlled by age and sex by stratification. No relationship observed "between the paired variables of hypertension treatment with" alcohol, coffee or tea consumption, smoking, home ownership, and income per capita. Also considered reported hearing defects, employment and perception of noise as a stressor.

Conclusions:

Authors : "Noise is very troublesome on streets with high volume traffic. Specific high blood pressure as a treated disease was mentioned significantly more often [in the high noise area than in the low noise area]."..."The data on men between the ages of 20 and 39 who lived in the loud-noise area revealed hypertensive treatment to be dependent upon length of residence ($p < 0.05$). This was not the case in the low-noise area ($p = 0.22$)." ..."The results of the investigation justified a prospective, interdisciplinary, epidemiological study, in which the physical measurements are correlated with the measured blood pressure data."

Overall Evaluation:

This cross-sectional survey is one of the better studies reviewed although it specifies the noise parameter poorly. As an ecologic study which cannot link individual hypertension status with levels of noise exposure, there was an attempt to verify the subject's perception of noise relative to loudness and duration. Individuals had a minimal potential exposure of 3 years in the residence of the interview. The study could have been strengthened by having blood pressure readings conducted at the time of interview.

(Scores on a scale of 0-9)

Noise Exposure = 1
Health Effects = 6
Epidemiologic Method = 6

Citation: Vopilkina, G.I.: The Influence of Working Conditions in the Textile Industry (Spinning and Weaving) Upon the Cardiovascular System and Higher Nervous Activity. Gigiena Truda i Professional'nye Zabolevaniia 4:17-22, 1959. (Russian)

Researchers and Institution where research performed:
District Hospital, Moscow.

Stated Purpose: To study the influence of production-related factors upon the vascular system and higher nervous activity.

Study Design and Sample:
: Occupational groups in textile industry: spinners and weavers.
: Cross-sectional group of subjects with blood pressures taken before and after work.
: 300 spinners and 300 weavers; noise exposure levels not described; unspecified number of workers in the packing and mechanical departments working under normal microclimate conditions.
: No information provided on sampling frame, sample size determination or response rate.

Data Sources : Not stated.

Bias Potential in Design:
Selection, non-respondent and measurement bias.

Noise Exposure:
Noise Description:
Source : Spinning and weaving room noises; looms, spinning machines discussed in article, but not identified by the author as noise sources.
Type : Industrial (textile plant); whether steady or nonsteady not reported.
Frequency Composition: Not reported.
Levels : Not reported.
Duration of Exposure: Not reported. Author states subjects for higher nervous activity study were on the payroll for 2-12 years. He did not report lengths of employment for the 600 subjects and controls measured on blood pressure.
Instrumentation: Not reported.
Measurement Procedure: Not reported.
Environment : Uncontrolled; not described.
Subjects : Workers of different age groups. Neither history of work exposures nor avocational exposures were reported. No information provided as to hearing thresholds or ear disease.
Evaluation : There is no indication of an attempt to measure noise parameters. Noise description information was not reported. Noise environment was not described. Study is very poor in regard to the noise parameter.

Health Effects:

CVS Response : Arterial blood pressure; methodology and definitions of hypertension and hypotension not defined.

Evaluation : Very little data and methodology presented. Study reports that arterial pressure of spinners and weavers decreases after work, whereas it almost does not change among the control group. Furthermore, when measured at home in the evening of a holiday, blood pressure was not reduced. These blood pressure changes could be produced by several factors other than noise. Author notes that with the high temperature in the spinning and weaving departments, the average weight loss in the course of the day was 1.5 kg.

Judging Causal Significance:

Strength of the Association: Not stated.
Statistical Methods: Not stated.

Control for Potential Confounders:

There was no evidence of controlling for potential confounders.

Conclusions:

Author : "It is clear from our documentation that an unfavorable microclimate and work-related stress do provoke characteristic disturbances in the reactions of the cardiovascular system and the higher nervous activity among the women working in the textile industry. This should give occasion to the elaboration of new prophylactic measures which would aim to improve further the working conditions of women."

Overall Evaluation:

This poorly designed cross-sectional study provides inadequate information for judging sample size, measurement of noise and health effects, and effects of the environment. Potentially confounding variables were not statistically controlled. Data were presented for selected individuals. It is unclear what group comparisons were actually made.

(Scores on a scale of 0-9)

Noise Exposure = 0
Health Effects = 4
Epidemiologic Method = 0

Citation: Zvereva, G.S., Onopko, B.N. and Ratner, M.V.: The Influence of Noise and Vibration on the Workers of the Flux-Dolomite Industry. Gigiena Truda i Professional'nye Zabolevaniia 2: 46-48, February 1975a. (Russian)

Researchers and Institution where research performed:
Institute of Hygiene and Occupational Diseases

Stated Purpose: The determination of the degree of this influence (high noise level and vibration) on the organisms of workers is thus the purpose of the study conducted.

Study Design and Sample:
: Occupational groups from limestone and dolomite crushing-enriching plants and quarries of the flux-dolomite combine.
: Cross-sectional data from measurements taken before and after a shift of work; no control group for noise; some comparisons between high frequency vibration and intense noise in crushing-enriching plants and low frequency vibration with noise in low and medium frequencies in quarries.
: 334 workers divided into 8 groups: 105 operators of transporters, 47 sifters, 41 crushers, 29 excavators, 26 workers at drilling stands, 30 assistant transporter operators, 26 excavators and drilling stand workers and 30 fitters.
: Workers aged 30-40 years.
: No information provided on sample selection and exclusions.

Data Sources : Data apparently collected primarily for study purposes.

Bias Potential in Design:
Bias due to lack of controls and noncomparable subjects within the study group (8 professional groups of various noise and vibration levels working in multiple physical environments). Selection bias probable.

Noise Exposure:
Noise Description:
Source : Not reported; 8 occupations listed.
Type : Industrial; not reported as to steady or nonsteady noise.
Frequency Composition: Quarries, excavation and drilling places: maximum energy in low and medium frequencies.
: Crushing-enriching plant; wide band noise with predominate high frequency components.
: Actual frequencies not reported.
Levels : Quarries, excavation and drilling places: general level of 95-100 dB.
: Crushing-enriching plants: 86-106 dB.
Duration of Exposure: Not reported; subjects had worked more than three years.
Instrumentation: SH-3M noisemeter and 1/3 octave analyzer Ash-2m. Compliance with standards not reported.

Measurement Procedure: Not reported; 164 work places measured for intensity and spectral composition of noise.

Environment : Uncontrolled; working environments and workers' relationship to noise sources not described.

Subjects : All subjects had worked in the noise environment more than 3 years; other work exposures not reported; no history of avocational noise exposures nor ear disease; hearing thresholds obtained with an AN-01 audiometer.

Evaluation : Noise sources and duration of exposure to noise not reported. Frequency composition only reported in general terms. Noise environments not described. Procedure for measuring noise not reported. Difficult to separate virbration and noise effects.

Health Effects:

CVS Response : Arterial pressure with a sphgynomanometer, but no definitions or measurement procedures provided;

: Some functional indices of nervous and muscular systems, ex. state of the capillaries assessed with a capillaroscope;

: Complaints including heart pains, fatigue, etc.;

: Objective symptoms such as trembling of the hands and asymmetry of arterial pressure and anisocoria.

Evaluation : No information provided as to diagnostic criteria and definitions nor of measurement procedures used. Observed increased capillary tone related to vibration. 8% anisocoria and 25% asymmetry of arterial pressure also reported. The pathophysiologic mechanisms and significance of the latter two measures are unclear. No evidence of readings taken prior to exposure for purpose of differentiating normal from asymmetry of blood pressure. This appears to be primarily a vibration study with steady reduction of vibrational sensitivity detected in all occupational groups in crushing-enriching plants where there was high frequency vibration and noise. No impairment of vibrational sensitivity was detected in workers in the quarries exposed to low frequency vibration. The major problem, however, was the failure of the authors to provide data to support their conclusions.

Judging Causal Significance:

Strength of the Association: Not relevant given the design and data available. Reports that tests of arterial pressure determined the tendency toward hypertension in 20% of those examined. No comparison groups. Apparently before-after shift measurements were treated as cross-sectional data.

Statistical Methods: No statistical tests reported.

Control for Potential Confounders:

Since this is cross-sectional data utilized in a descriptive mode, control for variables may not be appropriate.

Conclusions:

Authors : "The data obtained show that noise and vibration in the plants of the flux-dolomite industry have quite high levels and cause changes in hearing and disorders in the function of nervous and vascular systems typical of vibration-noise pathology."

Overall Evaluation:

This study design is inappropriate for determining associations between noise exposure and cardiovascular effects. No control or comparison groups employed. Before-after work shift measurement not utilized in in analysis. Even for descriptive purposes, the vibration effects probably confound the noise effects in this group of workers.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 1
Epidemiologic Method = 0

Citation: Zvereva, G.S., Ratner, M.V., and Kolganov, A.V.: Noise In a Milling Plant and Its Influence on Worker Organism. Gigiena i Sanitaria 11:104-105, 1975b. (Russian)

Researchers and Institution where research performed:
Scientific Research Institute of Occupational Hygiene and Occupational Disease in Donetsk

Stated Purpose: None

Study Design and Sample:
: Workers in pipe and sheet rolling plants
: Cross-sectional data; 340 workers exposed to the effect of interrupted noise had hearing thresholds, arterial pressure and pulse measured before the beginning of the work shift. Apparently there were repeat measures over time, but description too vague to judge.

Data Sources : Not stated.

Bias Potential in Design:
: Selection and non-response bias; no control group.

Noise Exposure:
Noise Description:
Source : Area 1 = pilger mills and cross-cutting aggregates; area 2 = cutting hot and cold metal; area 3 = rolling profiles and area 4 = rollers and cutters.
Type : Area 1 - percussive; area 2 - friction cutting; area 3 = friction rollers; area 4 = impulse and friction noise, non-periodic and unstable parameters; primarily intermittent rolling mill noise.
Frequency Composition: Not adequately reported and not clear; area 1 = rise time = 40 m sec; area 2 = rise time 100 m sec and low frequency; area 3 = not reported; area 4 = rise time 20 m sec.
Levels : Area 1 = 122 dB, "high M & K", area 2 = not reported; area 3 = 115 dB; area 4 - up to 142 dB. On-going intensities are not reported.
Duration of Exposure: area 1 = .2 sec; area 2 = long vibrations and pauses (several seconds); area 3 = not reported; area 4 = .1 sec. Duration of employment or service time reported in categories of below 1 year, 1-2 yrs., 3-5 yrs., 6-9 years and 10 years or more.
Instrumentation: No use of dosimeters reported; pre-calibrated loop oscillagraph N-117 and a Nish V-1 noise and vibration meter.
Measurement Procedure: Not reported.
Environment : Work areas of pipe and sheet rolling plants; although environment was monitored, the degree of control is not clear.
Subjects : No information as to history of other vocational exposures, history of avocational noise exposure, or ear disease. Hearing thresholds obtained before and after noise exposure.
Evaluation : Dosimeters were not used in measurement of noise. Measurement procedures and duration of exposure (other than years employed) were inadequate for noise assessment.

Health Effects:

CVS Response : Arterial pressure, pulse, complaints and state of pain, vibration and temperature sensitivity.

Evaluation : No diagnostic criteria for any measure of cardiovascular response including blood pressure; no quantification of the blood pressure response.

Judging Causal Significance:

Strength of the Association: No quantification of CVS responses.

Statistical Methods: None reported.

Control of Potential Confounders:

No evidence of consideration of confounders.

Conclusions:

Author : "One-hundred sixty-eight persons (50%)...were found to have hearing impairment. ...changes in the neurological state were found in many workers...Complaints in many cases were combined with objective symptoms: disorders of arterial pressure (more often elevated pressure), pulse lability, decrease of vibration and pain sensitivity (up to full anesthesia), thermal asymetry, trembling of arms and eyelids, instability in the Romberg position."

Overall Evaluation:

Design described too poorly and failure to report blood pressure data invalidates this study for the purpose of judging associations between noise and cardiovascular response.

(Scores on a scale of 0-9)

Noise Exposure = 3
Health Effects = 1
Epidemiologic Method = 1